chemical engineering
advances...
and
SEE
PAGE
TWO

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specify Shell Chemical products for surface coatings

If you manufacture decorative or protective surface coatings, depend on Shell solvents and resins for quality and economy.

Shell's family of *solvents* meets or exceeds highest standards, and gives you complete formulating flexibility.

For finishes that are resistant to abrasion, impact, and chemical attack—*Shell's Epon® resins* are outstanding.

In the manufacture of alkyd resin and ester gum coatings, Shell *glycerine* assures both quality and performance.

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SHELL

MAY 19, 1958

JOHN R. CALLAHAM, Editor-in-Chief

Reader Feedback . . . .

Early this year I asked you to let me know how you felt about our new biweekly issues.

Since so many of you have responded, I think it's only fair to give you an interim report, a feedback of what you've told us so far . . .

• By the end of January, after only two biweekly issues had come out, the ratio of favorable to unfavorable reactions was about 7:3.

• By mid-April, this ratio was running 17:1 in favor of our move.

• Before we increased frequency, some of you were worried about "more reading matter." This concern seems to have virtually disappeared as you found the material easier to get to and faster to read. To date only four readers have objected for this reason.

• On the other hand, over two-thirds of those we've heard from say they like the broadened coverage and additional editorial pages that biweekly frequency has made possible.

• Practically all readers now say they find CE "more interesting," "more timely" and "more useful."

• Among other comments mentioned most often: "easier to read; less bulky; easier to take home in my briefcase; more material down my line; easier to find stories of most interest."

• Among the adverse comments (none over five mentions each): "written like a newspaper; no technical meat; too hard to file; nothing for the research chemist; too many ads mixed with editorial."

We're still getting letters almost every day, of course, but that's the story to date.

I want to thank all of you who've taken the time and trouble to send us your reactions. Your landslide vote of approval has made us more determined than ever to keep the "new" CE up to your expectations at all times.

We know it won't always be easy!

TENTH OF TWENTY-SIX ISSUES

10/26

GUIDED TOUR

What chemical engineers are contributing to the U. S. rocket program

Giant rockets are just big chemical reactors. Many of their basic problems are those the chemical engineer knows best: thermodynamics, fuel design, materials of construction. Here's a timely, three-part report on missile engineering, new materials to contain high temperatures, the search for more powerful fuels. (p 145)

What's ahead in business spending

Business is banking on a short recession and a resurgence of growing markets. Disappointing sales aren't affecting research and development budgets. And they'll pay off in future profits. (p. 86)

Photodrawings cut costs

How-to-do-it details on the new way to supplement and replace conventional draw-

Chemical

May 19, 1958

GUIDED TOUR

ing practices. You'll find it most useful when you want to visualize or make changes in your present production setup. (p. 161)

Conversion calculations simplified

Seven new charts take the tedious work out of calculating percent conversion in staged reactors. They're good for first or second order reactions and for two, three and four-stage reactor systems. (p. 166)

What's new in stainless steels

Many new members have been added to the stainless steel family. Here's your chance to meet and evaluate them. Their special properties will help you with corrosion and high-temperatures. (p. 180)

You have a key spot in the rocket age

It looks as if there's a critical shortage of chemical engineers in the rocket industry. They don't seem to be aware of it, but they're vital in the race to put the U. S. out in front. (p. 187)

CE is edited for the engineer concerned with chemical operations, whatever his function . . . administration, production and plant operations, design and construction, research and development, sales and purchasing. More engineers subscribe to CE than to any other magazine in the field. Print order this issue:
47,467

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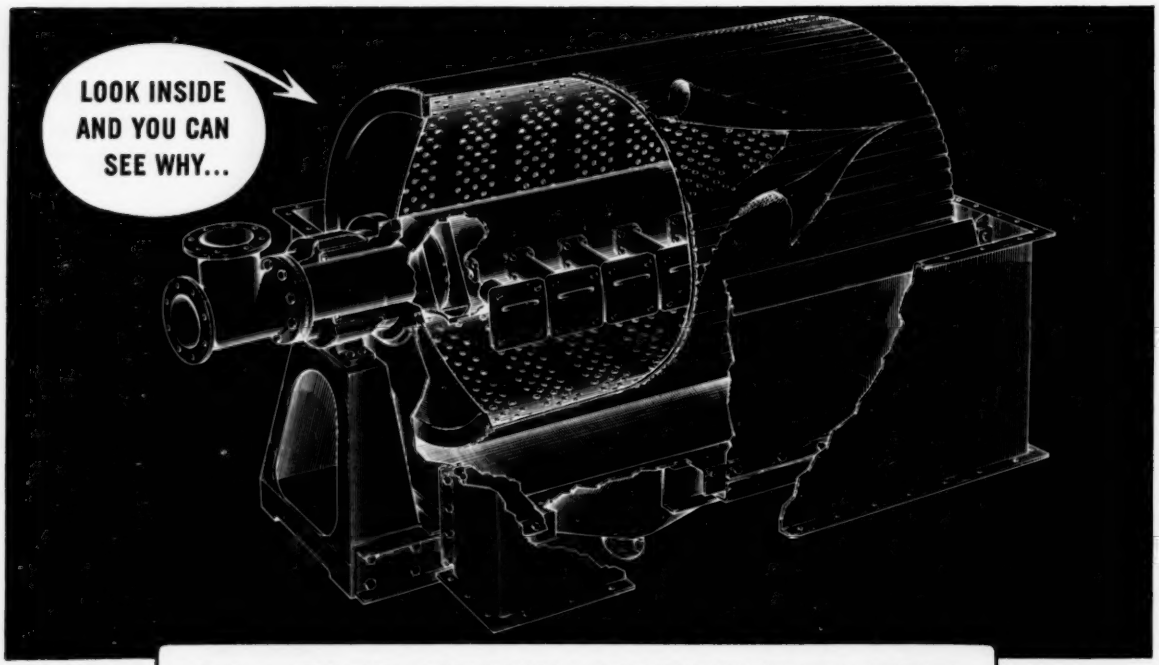
Specify This Simple, Sturdy
Single Cell Rotary Vacuum Filter

for HIGHEST CAPACITY PER FOOT OF FILTER AREA and LOWEST FILTERING COST PER TON



The BIRD-YOUNG VACUUM FILTER

Almost the entire drum is under vacuum. Filtrate flow is completely unhampered by pipe lines, valves or obstructions of any kind.

The slotted shoes pulsate low pressure air for extraordinarily effective cake removal.

Slow filtering solids can be discharged in thin cakes at high drum speed thus achieving high output plus thorough dewatering and washing.

Multi-stage, counter-current wash is effected with sharp separation of wash from filtrate.

It has been definitely established on many applications that the Bird-Young Single Cell Filter has *two to six times the capacity per foot of filter area* of multi-cell, drum filters. The complete unit takes up minimum floor space (48 sq. ft. average). It may be totally enclosed and fume-proofed.

Write for Bulletin containing detailed specifications and avail yourself of the test facilities at the Bird Research and Development Center

BIRD

Leading Authority on Solids-Liquids Separations

Builders of

- Bird Continuous Centrifugal Separators
- Bird-Prayon Continuous, Rotary, Horizontal Vacuum Filters
- Bird-Young Single Cell Rotary Vacuum Filters
- Bird Horizontal Tank, Vertical Leaf Pressure Filters
- Bird-Humboldt Screen Type Oscillating Centrifuges
- Bird Suspended Centrifugals • Bird Centrifugal Classifiers
- Bird Continuous Centrifugal Coal Filters • Bird Polishers

For specific information on individual machines write:
BIRD MACHINE COMPANY
South Walpole, Mass.
Regional Offices:
Evanston, Illinois
Walnut Creek, California
Atlanta 9, Georgia

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Potential profits float away too. To cut down on your losses, here's a new packaged sulfur recovery unit. It's conversion efficiencies are high; operating costs, low.

Although processors have slashed capital spending 86

Most firms are sinking healthy sums into research and development projects. They expect to top today's $1 billion outlay by another $0.2 billion or so, come 1961.

Update your rocket and missile technology 145

Especially where rocket motors and fuels are concerned, many missile design problems are chemical engineering problems. This report brings you the latest facts.

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Here's how one firm's engineers get design ideas across to craftsmen faster and at a lower cost. They combine conventional drafting procedures with photography.

To find reactor conversions more easily 166

Use these charts to figure percent conversion for two-, three-, or four-stage reaction systems, in continuous concurrent or continuous countercurrent operations.

Can you handle mass-transfer problems? 169

This refresher tells you how to handle calculations of steady-state mass transfer using mass-transfer coefficients in the design of extraction and absorption equipment.

CRYOGENIC* KNOW-HOW

...highlights from the Record

*Technology of ultra-low temperatures

1907 LINDE installed first air liquefaction plant in America

1912 Built the first American-made air liquefaction plant

1914 Established scientific laboratories for gas and chemical research, experimentation, and testing

1916 First commercial argon production

1917 First natural gas liquefaction plant to produce helium designed and built for U. S. government

1917 Argon extensively used to fill light bulbs

1917 **LINDE became a part of UNION CARBIDE**

1918 **Operations extended to Canada**

1920 Development of rare gas separation processing

1922 Began commercial production of neon

1928 Started development of system for liquid oxygen and nitrogen

1932 First customer liquid oxygen storage and conversion unit installed

1932 First liquid oxygen truck delivery to customer units

1935 High-pressure conversion equipment adapted to truck use

1935 Oxygen converted from liquid to gas on trucks

1937 **Powder-vacuum insulation reduced heat leak to contents by a factor of 10**

1939 **First vacuum-insulated railroad tank car shipment of liquid oxygen**

1940 First combination liquid and gaseous oxygen plant

1944 Liquid oxygen producing plants, transport containers, and storage units made for government

1946 Basic patent for powder-vacuum insulation issued

1946 First 25,000,000 cu. ft. liquid storage reservoirs for oxygen, nitrogen, or argon

1948 First 140 ton a day low-purity oxygen-producing unit

1949 First 360 ton a day on-site oxygen-producing unit for chemical industry

1950 First liquid nitrogen equipment for shrink fitting

1951 **Heat leak to contents further reduced by a factor of 10**

1953 **First 450,000 cu. ft. capacity vacuum-insulated trucks**

1953 First automatically-operated on-site oxygen plant

1955 First 3000 cu. ft. compact cylinder for storage, transport, and conversion of liquid oxygen

1957 3000 cu. ft. cylinder adapted to shipment of liquid nitrogen, argon, and hydrogen

1957 Continuing progress in decreasing heat leak to contents

1957 Liquid oxygen distribution system requiring no external power source

1957 First automatically-operated 120 ton a day on-site oxygen plant

1957 Single shipment of 10,000 liters of xenon

1958 Continual commercial shipments of liquid hydrogen

Linde TRADE MARK

UNION CARBIDE

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Some Cold Facts About CRYOGENICS and 'LINDE'

Since installing the first oxygen liquefaction plant in America in 1907, LINDE has continuously expanded its Cryogenics capacity—scientific, engineering, and production. How much? Look!

PRODUCTION

More than 50 plants for producing liquid or gaseous oxygen, nitrogen, argon, hydrogen, and rare gases (neon, krypton and xenon).

Here are the capacities of a few centrally-located plants producing liquid:

Essington, Pennsylvania — **500 tons a day** (12,000,000 cu. ft.)

Fontana, California — **175 tons a day** (4,200,000 cu. ft.)

Ashtabula, Ohio — **500 tons a day**

Others at Kittanning (**700 tons**), Seattle (**20 tons**), Houston (**40 tons**), Birmingham (**20 tons**), East Chicago (**900 tons**), *Etc.*...

Most on-site plants operated for single-customer use produce high-purity gaseous oxygen. Capacities range from 10 tons a day to more than 500 tons a day. (One ton equals 24,150 cu. ft., N. T. P.)

DISTRIBUTION

Over 100 storage and distribution installations, plus hundreds of customer units are serviced by a LINDE built fleet of:

More than **500** liquid-carrying railroad box tank cars.
Standard capacity: 1,000,000 cu. ft. (gaseous equivalent)

Over **350** liquid-carrying trucks and trailers:
Capacity: 60,000 to 450,000 cu. ft.
(More than ⅔ of these are equipped to convert liquid to gas at 3000 psi pressure)

STORAGE AND STORAGE-CONVERSION UNITS

Portable

Aircraft storage-conversion—oxygen—
Capacity: 5, 10, 25 liters

Storage-conversion cylinders—liquid oxygen—(Adapted also for liquid nitrogen, argon, neon, hydrogen service) **Capacity: 3,000 cu. ft.**

Special liquefied gas refrigerator containers for biologicals, cryogenic research —
Capacity: 25 and 640 liters

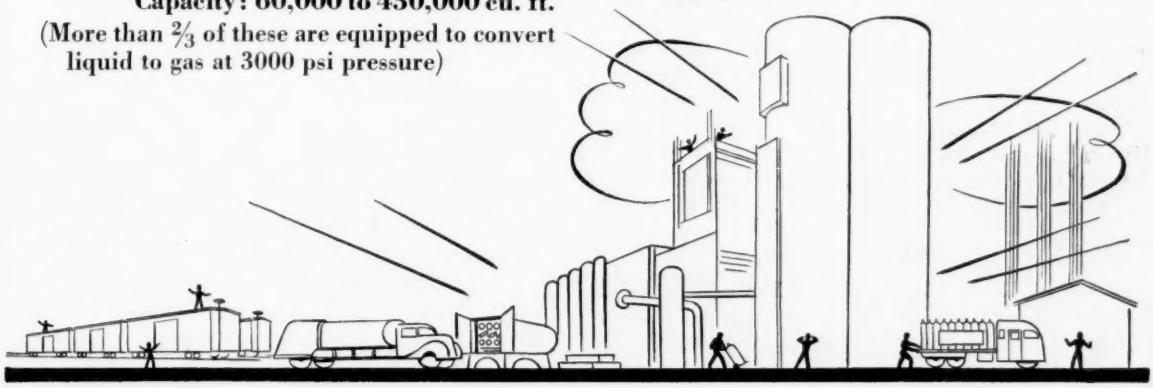
Others with capacities up to 450,000 cu. ft., including mobile pumping units

Stationary

About **650** liquid storage or combination storage and conversion units in service at customer, distributor, or mass-plant locations—
Capacity: 10,000 to 75,000,000 cu. ft.

RESEARCH AND ENGINEERING

Of the combined staff of 1300 at three laboratories, more than 1000 engineers, scientists, and technicians are constantly adding to LINDE's knowledge of Cryogenics and supporting sciences. Years of solving low-temperature problems, plus our up-to-date know-how of Cryogenic engineering, equipment, and liquefied gas applications are yours when LINDE becomes your source for cold facts and materials.



Put LINDE's vast experience in Cryogenics to work for you

Call or write Department **CG-52,** LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd St., New York 17, N. Y.
In Canada: Linde Company, Division of Union Carbide Canada Limited.

EXPERIENCE — Successful completion of the spherical reactor, other new designs and customer projects are the responsibilities of C. S. Brown, Manager of Product Development, (at right) and E. E. Deuring, Director of Product Engineering. They coordinate all phases of mechanical and process activities to *exactly* meet your specific performance requirements.

ENGINEERING

a new look in reactors

Another Glascote first brings you higher pressures and vaporization rates, larger capacity plus superior glass lining

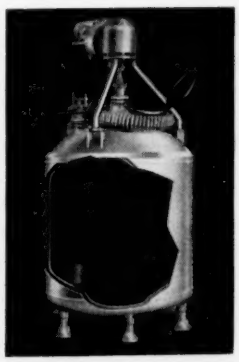
Because of Glascote's long service to the chemical processing industry, they foresaw the need for higher reactor pressures.

Heretofore, reactors could not offer the processing advantages of units capable of operating above the 200 psi ceiling. Glascote engineering accepted the challenge. They went to work . . . came up with tomorrow's design today . . . the first glass-lined spherical reactor.

What will it do? This revolutionary design makes possible internal operating pressures up to 330 psi . . . jacket pressures to 250 psi. *That's 130 psi over any existing reactor!*

This remarkable accomplishment was executed by what we consider the finest creative engineering group in the industry. And they have demonstrated their ability many times . . . by developing these engineering firsts: Rotary mechanical seal, double wall dip tube, welded sealer rings and many others.

Why not tell us about your design, process and application problems. We'll put the same kind of engineering effort and service to work for you.



If your present processing operations do not require higher pressures, you can get the same proven engineering that produced the spherical reactor in Glascote's standard and custom-built line of glass-lined reactors, columns, storage tanks, rotary dryer-blenders, heat exchangers, pipe and fittings and accessory items.

Glascote®
PRODUCTS, INC.
Cleveland 17, Ohio
Sales offices or agents in principal cities, Export sales:
A. O. Smith International S.A., Milwaukee 1, Wis., U.S.A.

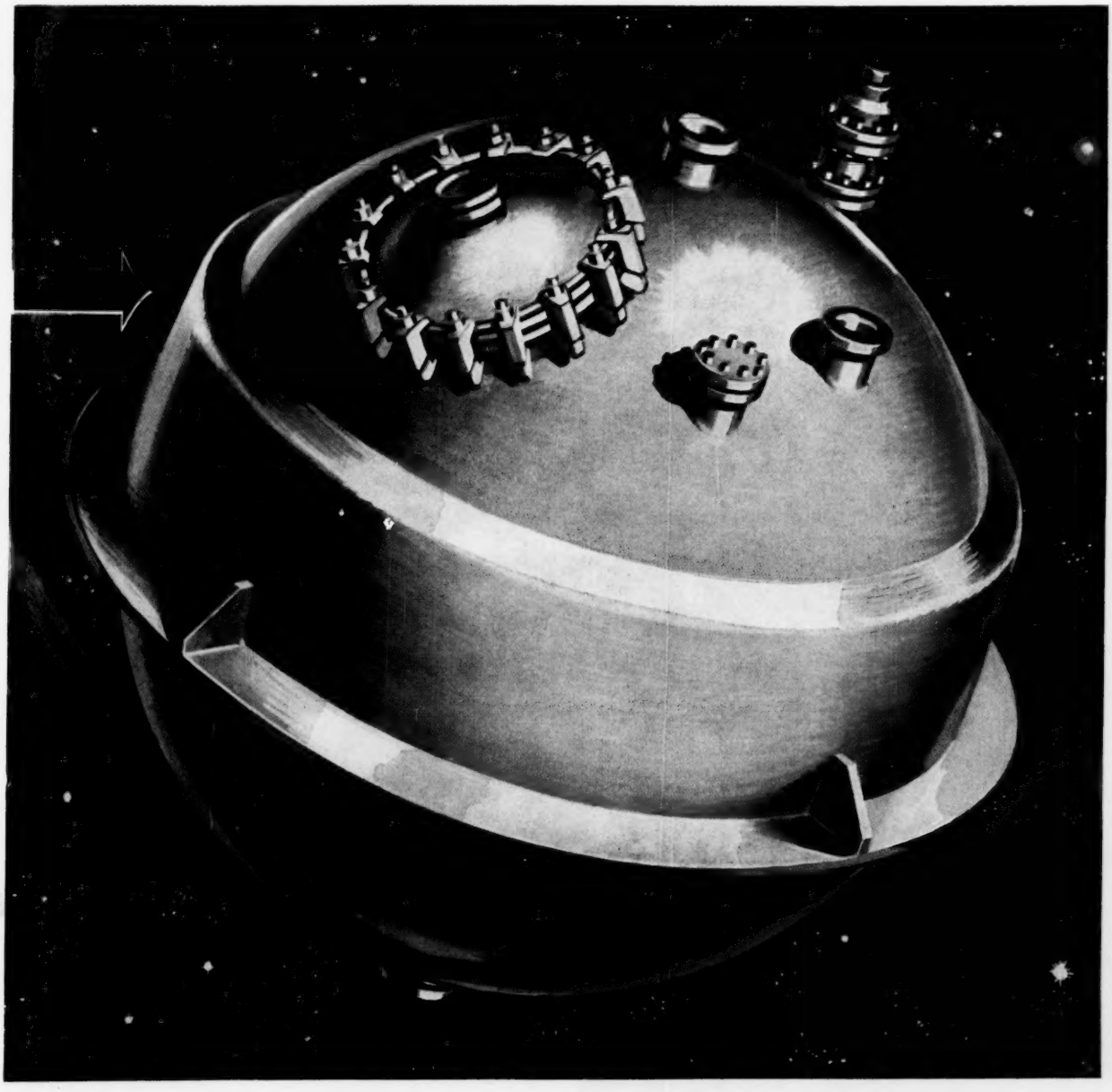
A subsidiary of A.O.Smith Corporation
World's largest manufacturer of glass-lined steel products

What's behind the Glascote sales engineer... and his glass-lined products?

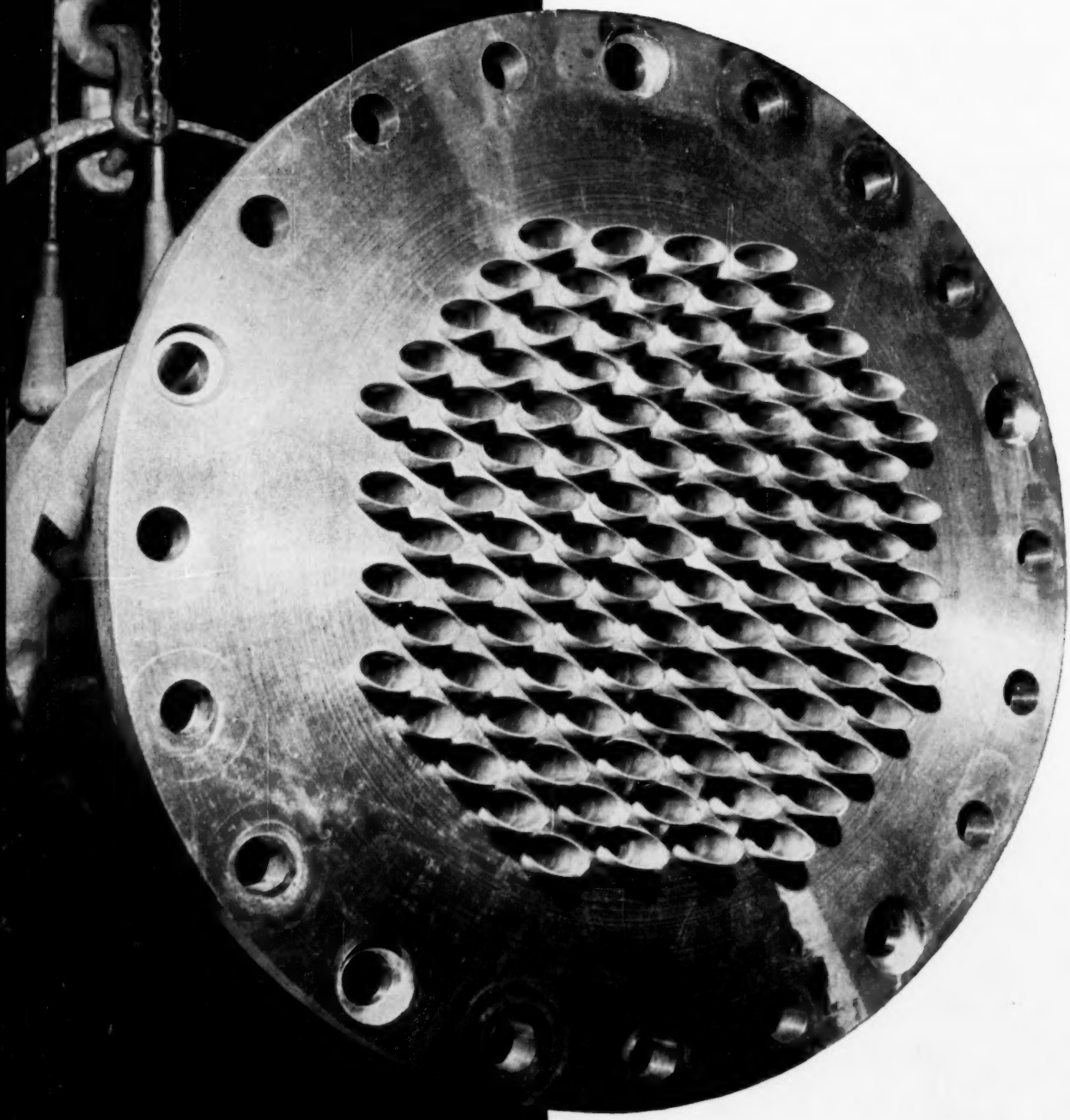
— 38 years of Glascote experience in manufacturing glass-lined vessels and tanks for the process industries. Through continual research and development engineering, Glascote stays ahead of the demand for new and improved processes requiring a wider range of corrosion, temperature and thermal shock-resisting properties for glass linings.

In addition, Glascote gives you preventative maintenance help, in-plant seminars . . . specialized field service. Glascote is free to call upon the 83 years of accumulated research, engineering and manufacturing experience of A. O. Smith Corp.

He's an experienced engineer who can give you on the spot product and process assistance.



Working with Aluminum



is a Talent at...

Vulcan manufacturing

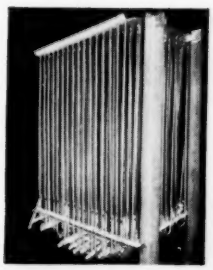
In the application illustrated at the left, Vulcan Manufacturing successfully designed and built this large heat exchanger of type 3003 aluminum.

We do not consider this unusual.

It does, however, indicate to you a talent for working with the various metals and special alloys that are more and more becoming a part of today's process equipment. This heat exchanger is typical of the wide variety of custom designed process components engineered and fabricated at Vulcan and now in successful operation. This also includes fractionating towers, extractors, evaporators, and special pressure vessels. And it encompasses wide experience with many materials including copper, stainless steel, carbon steel, aluminum, nickel, Everdur, Monel, Inconel, Hastelloy, Carpenter 20, Karbate — even plastics.

We'd like the opportunity to put this experience to work for you. For more information, call or write:

Copper ...
and Everdur were combined in the fabrication of this condensing section



Stainless ...
type 316 was used for this ultrahigh vacuum fin tube condenser

Monel too!
Used here on a bubble cap tray for a chemical reaction tower

Vulcan manufacturing

120 Sycamore Street, Cincinnati 2, Ohio, Dunbar 1-1400

Designers and builders of process equipment

VUL-603

APPLETON type "ECC"

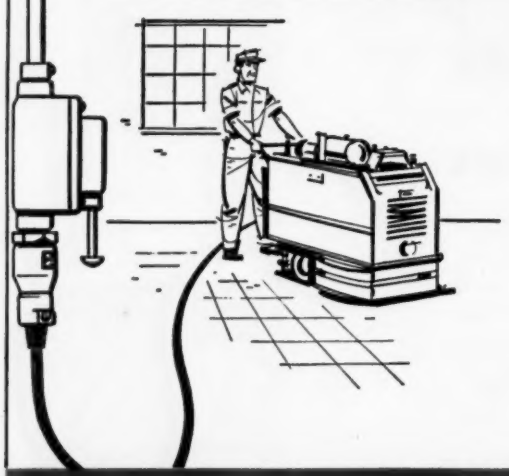
explosion-proof, dust-proof cable connector

(CLASS I, GROUPS C and D; CLASS II, GROUP G)

UL approved

A factory-sealed, explosion-proof connector used between a portable extension cord and an explosion-proof unilet or housing

Illustration shows an APPLETON "ECC" Explosion-Proof Cable Connector in use with a portable Floor Scrubber.



From its rugged aluminum housing which withstands years of extreme rough usage, to its lead wires protruding 12" from the body for faster, easier splicing, this APPLETON "ECC" Connector has every desirable quality feature.

The current carrying lead wires for example, are solidly moulded into the connection blocks: can't work loose under vibration. An auxiliary cord clamp is provided to prevent strain on the wire connectors resulting from sudden tugs on the cord. This clamp fastens tightly by screw pressure on a tapered rubber bushing in the form of a sleeve... effectively sealing the cord entrance. Three pressure-type solderless lugs on the load end of the "ECC" allow quick connections to be made with Type S Rubber-Covered Cord in ranges of #18 to #12, AWG. The grounding connector is plainly identified with a letter "G" on the block. Only the APPLETON Type "ECC" Explosion-Proof, Dust-Tight Cable Connector offers so many worthwhile features for such an economical price.

Sold Through Franchised Wholesalers Only

APPLETON ELECTRIC COMPANY

APPLETON ELECTRIC PRODUCTS

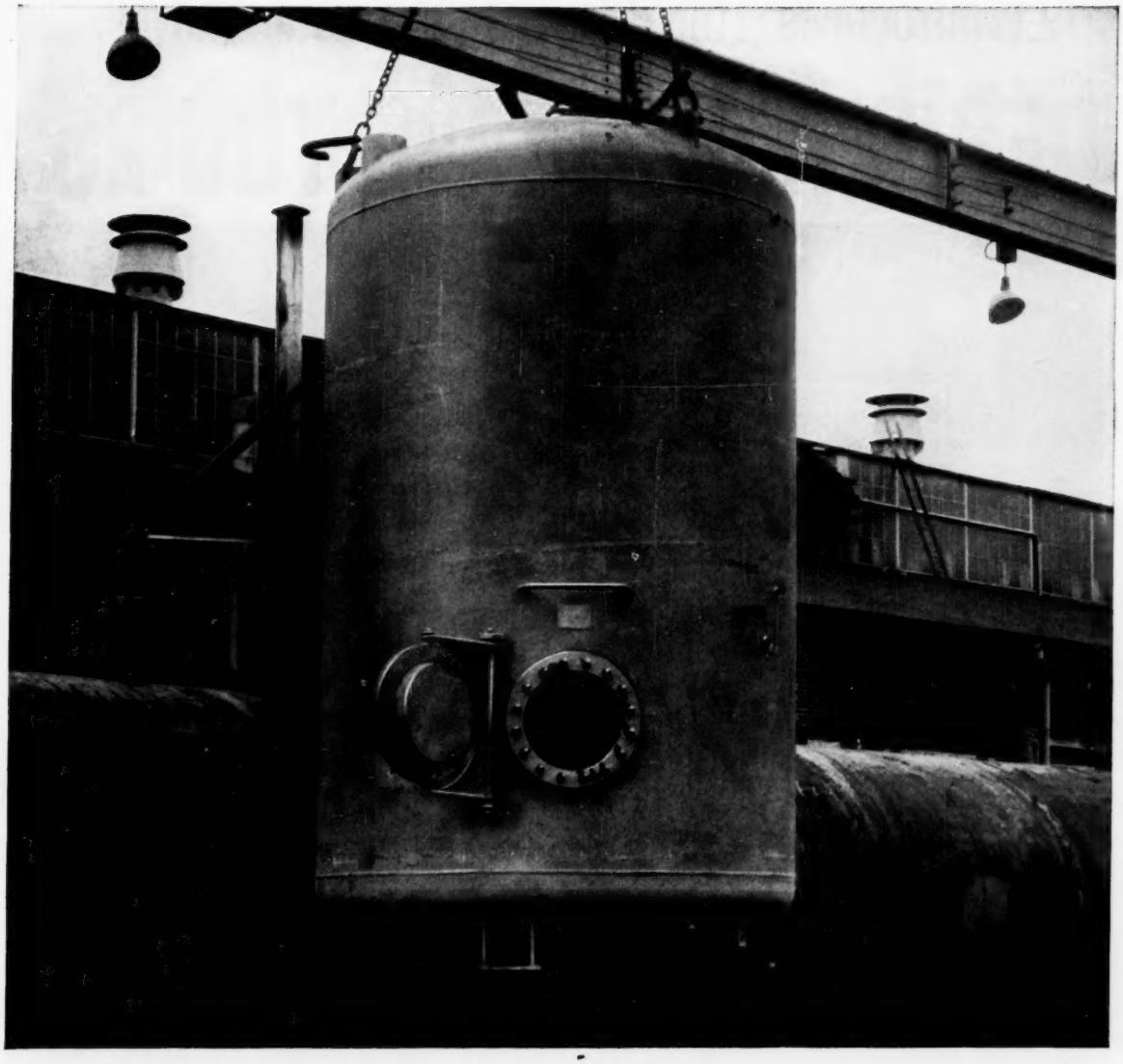
Also Manufacturers of:

"ST" Series Connectors

Outlet Boxes

Malleable Iron Unilet Fittings

Reelites



A decade of repeat orders... to the tune of 330 tanks

The only thing unusual about this tank is that it is one of 330 units made at Downingtown to the same basic design specifications.

It measures 8′ in diameter and 12′ high. Material is carbon steel. Interior welds are ground flush and smooth. Operating pressures are nominal.

But the tank represents customer satisfaction with Downingtown workmanship, delivery, price—330 times over.

Send for bulletins detailing our experience and facilities. Our plant is equipped for welding 2-inch thick material—and for lifting 80 tons.

Downingtown Iron Works, Inc.

140 Wallace Ave., Downingtown, Pennsylvania

division of PRESSED STEEL TANK COMPANY Milwaukee

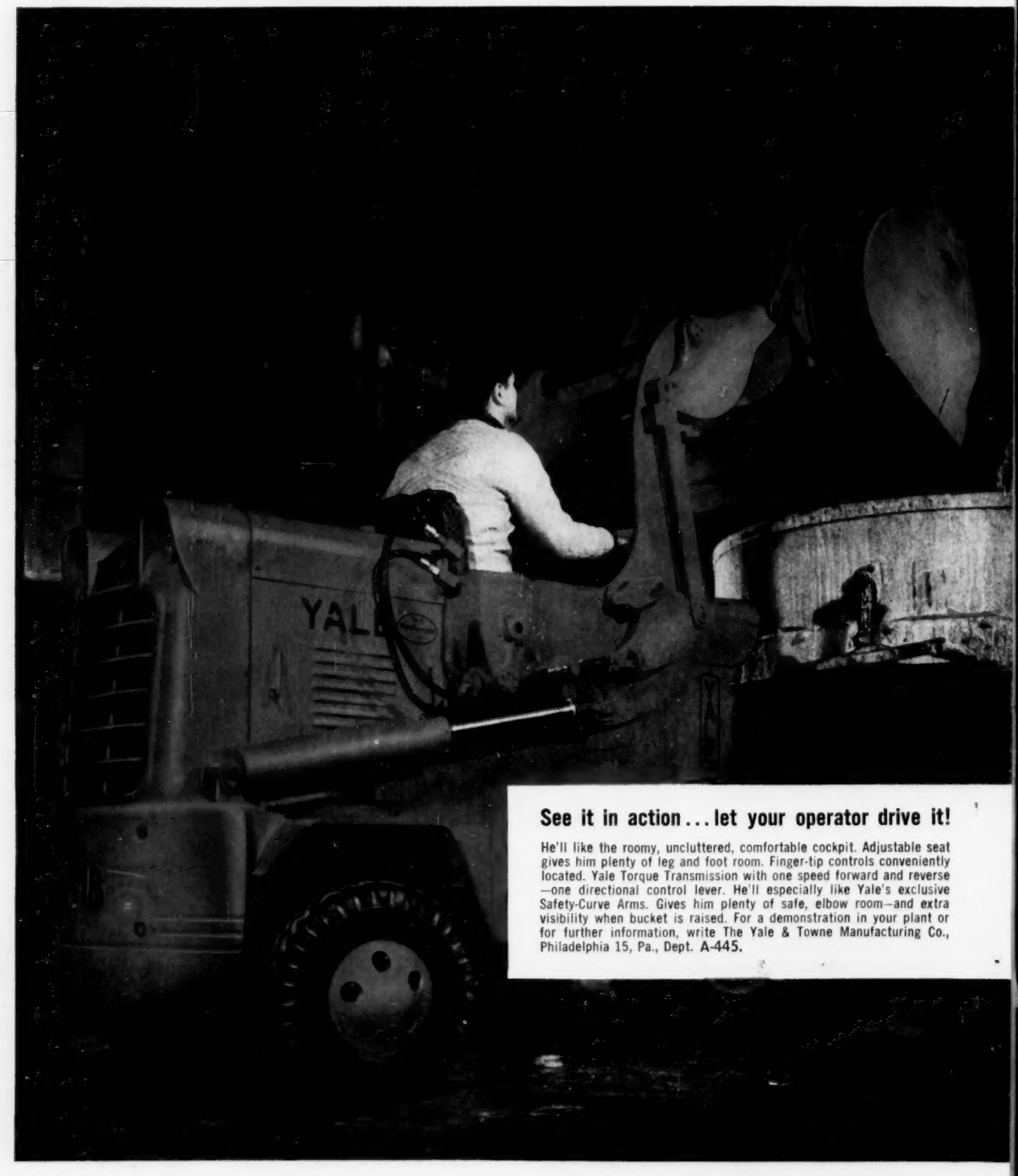
Branch offices in principal cities

HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

YALE introduces...the INDUSTRIAL tractor shovel

DESIGNED TO GIVE YOU 25%



See it in action... let your operator drive it!

He'll like the roomy, uncluttered, comfortable cockpit. Adjustable seat gives him plenty of leg and foot room. Finger-tip controls conveniently located. Yale Torque Transmission with one speed forward and reverse —one directional control lever. He'll especially like Yale's exclusive Safety-Curve Arms. Gives him plenty of safe, elbow room—and extra visibility when bucket is raised. For a demonstration in your plant or for further information, write The Yale & Towne Manufacturing Co., Philadelphia 15, Pa., Dept. A-445.

MORE WORK EVERY HOUR

through these exclusive Yale features . . .

- Yale Torque Transmission (fully automatic)
- 45° ground-level bucket tipback
- Safety-curve arms
- Accelerates to operating speed of 8 mph. in 3.5 seconds—to a speed of 13 mph. in 5.5 seconds
- 6 foot dumping clearance
- Sealed brakes
- Front and rear operating lights

At last—a tractor shovel designed especially for industry! Whether you handle bulk chemicals, sand, gravel, scrap or raw materials, you'll get more productive work at less cost per work unit with this new concept in a tractor shovel.

Yale designed it for tight areas—built it *compact* (only 117" overall length) so that it can maneuver in any aisle wide enough for a wheelbarrow. *Accelerates to an operating speed* of 8 mph. in 3.5 seconds and to a top speed of 13 mph. in 5.5 seconds. Exclusive *Yale Torque Transmission (fully automatic)* permits quicker, smoother starting, eliminates shifting, provides more power under load conditions—in a word, *speeds cycle operations*. This extra speed, plus the greatest carrying capacity of its class (full 2500 lbs.) means *up to 25% more work per hour*.

Yale's loader-linkage design offers unique advantages. Exclusive 45° *Ground-Level Tipback* insures the ultimate in loading action—and a grade-level carrying position to minimize spillage. Exclusive 6 foot *Dumping Clearance* is highest on any model of similar wheelbase. Bucket is *Automatically Self-Locating*. Operator merely lowers from full dump-position to ground-level—bucket automatically returns to digging position.

a product of Yale's integrated design—these engineering advances are standard features

- Gasoline; LP-Gas powered
- Sealed hydraulic system—keeps dirt out
- Pre-cleaner—air cleaner combination
- Extra strong heavy welded steel frame—greater safety, longer life
- Automatic bucket return to digging position
- Carrying capacity of 2500 lbs.—bigger load capacity
- Short wheel base—minimum turning radius
- Sealed generator and distributor
- Balanced weight distribution
- Maximum speeds up to 13 mph.

YALE*
*REG. U. S. PAT. OFF.
YALE & TOWNE

INDUSTRIAL LIFT TRUCKS & TRACTOR SHOVELS • HOISTS

GASOLINE, ELECTRIC, DIESEL & LP-GAS INDUSTRIAL LIFT TRUCKS • WORKSAVERS
WAREHOUSERS • HAND TRUCKS • INDUSTRIAL TRACTOR SHOVELS • HAND AND ELECTRIC HOISTS

YALE MATERIALS HANDLING DIVISION, THE YALE & TOWNE MANUFACTURING CO. MANUFACTURING PLANTS: PHILADELPHIA, PA.; SAN LEANDRO, CALIF.; FORREST CITY, ARK.

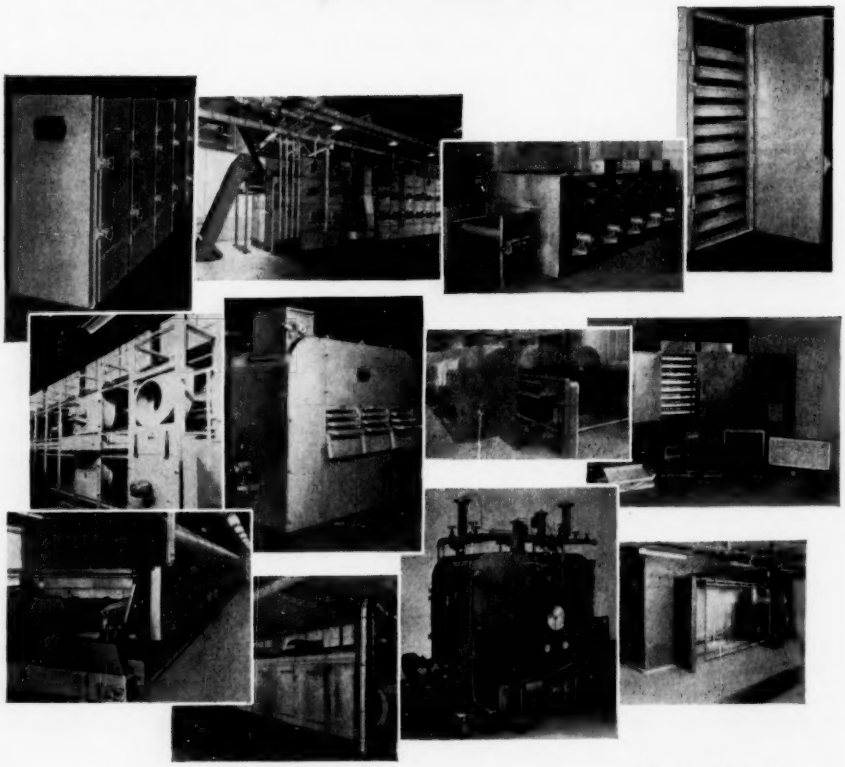
MODERN DESIGN
ADVANCED ENGINEERING
PROVEN PERFORMANCE

For the Process Industries

DRYERS by SARGENT

PRODUCTS DRIED BY SARGENT *include*

Abrasives
Asbestos
Berries
Briquettes
Calcium Carbonate
Cereals
Chemicals
Clay Fillers
Cocoa
Coconut
Carbon Black
Coffee
Explosives
Feedstuffs
Fertilizers
Flashless Powder
Fruits
Grains & Seeds
Inks & Pigments
Kaolin
Latex
Leather
Nuts & Oils
Paints
Paper & Paper Products
Pharmaceuticals
Plastics
Proteins
Rice
Rubber — Natural & Synthetic
Sensitive & Unstable Materials
Soap Chips
Soda Lime
Small Metal Parts
Starch
Tapioca
Textiles — Fibre, Tops, Yarns
Tiles
Tobacco
Vegetables
Waste Sludges
Wood and Building Products



SARGENT DRYERS
(Illustrated Above)

PHARMACEUTICALS, 5 sections of 10-section, 100-tray dryer; Reclaimed **RUBBER** (triple-decker) dryer; **PILOT PLANT** dryer; **PETRO-CHEMICAL** plant, 40-tray dryer — 2 stacks, 10 trays high, 2 trays deep; **COCONUT** dryer; **CHEMICAL** plant, 9-tray dryer for reclaimed rubber; **SKEIN** dryer; **COTTON SEED OIL** plant tray dryer; **TOBACCO** dryer; **TEXTILE STOCK** dryer; Portable **RESEARCH LABORATORY** dryer; **LEATHER** dryer.

There's a SARGENT DRYER to do the job for the Process Industries — conveyor, or tunnel, or pole. Truck dryers. Tray Dryers. Stationary or Rotary Dryers. High speed or low, heavy capacity or light; continuous or batch methods. Research Laboratory Dryers. Pilot Plant Dryers.

Coolers and Evaporators and SARGENT FEEDS — standard and special; Vibrating Screen Feeds, Conveyor Feeds, Air Stream Feeds.

Sargent's Drying Research Laboratory invites your inquiry, no matter what your drying problems may be.

C. G. SARGENT'S SONS CORPORATION
Graniteville, SINCE 1852 Massachusetts

PHILADELPHIA 19 — F. E. Wasson, 519 Murdock Road
CINCINNATI 15 — A. L. Merrifield, 730 Brooks Avenue
CHICAGO 44 — John Law & Co., 5850 West Lake St.
DETROIT 27 — Clifford Armstrong Co., 16187 Grand River Ave.
HOUSTON 17, TEX. — The Alpha Engineering Co., Box 12371
CHARLOTTE, N.C. — W. S. Anderson, Carolina Specialty Co.
ATLANTA, GA. — J. R. Angel, Mortgage Guarantee Building
TORONTO 1, CAN. — Hugh Williams & Co., 27 Wellington St. East

50 years

of making better instruments

May 1, 1958 marks the 50th anniversary of The Foxboro Company. Fifty years of leadership in process instrumentation. Fifty years of "either making a better instrument . . . or not making it at all."

On the next several pages are brief descriptions of current "Foxboro Firsts" that exemplify this basic company principle. Instruments that have contributed substantially to improved measurement and control throughout the process industries. Instruments that demonstrate what Foxboro leadership really means.

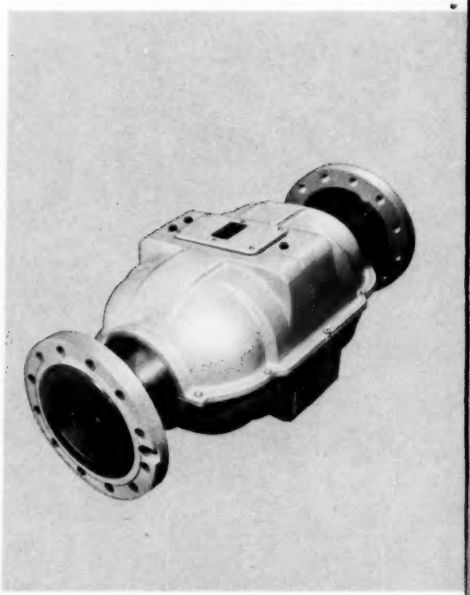
FOXBORO

REG. U.S. PAT. OFF.

CREATIVE DESIGN AND MANUFACTURE OF INSTRUMENTS
AND INSTRUMENT SYSTEMS FOR MEASURMENT AND CONTROL OF PROCESS VARIABLES.

Foxboro
makes
a better
instrument

—or Foxboro
doesn't
make it!



flow meter with
NO flow restrictions

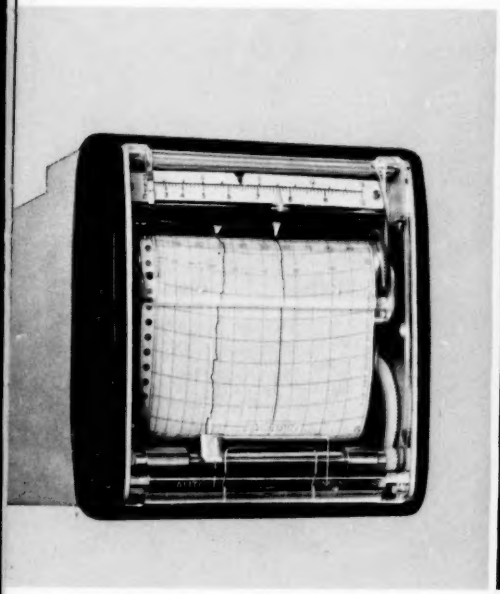
FOXBORO MAGNETIC
FLOW METER

The Foxboro Magnetic Flow Meter, first introduced in 1954, represents a completely new approach to liquid flow measurement . . . an approach that triumphs over such metering headaches as turbulence, loss of head, density variations, viscosity, temperature changes, and plugged measurement connections.

A magnetic field is maintained across the meter tube. Liquid flowing through this field creates a voltage proportional to velocity. Flush electrodes pick up and transmit this voltage to a Foxboro Dynalog Recorder.

Magnetic Flow Meters are available in pipe sizes from 1/10 inch to over 6 feet. Ideal for measuring flows of chemicals, pulp stocks, slurries, and many other viscous and corrosive liquids. Equally effective for clear liquids.

Write for detailed Bulletin 20-14B.



"full-scale" small-case instrument for centralized control

CONSOTROL* RECORDING CONTROL STATION

A small-case control station — compact yet with full-scale readability — is one of Foxboro's notable contributions to the centralized control field. The Consotrol Control Station, shown above, has a full-scale, 4-inch chart — the same length scale used on 12-inch circular chart instruments. Yet, four of these Consotrol Instruments can be panel-mounted where one conventional instrument used to go.

This Recording Control Station is a combination of the Consotrol Recorder and the Model 58 Controller, which mounts on the back of the recorder, or near the process.

With its unique "floating disc" design, and no slack diaphragms, the Model 58 quickly earned its reputation as the outstanding controller for the process industries.

Write for Bulletins 13-18A and 13-19.

*Reg. U.S. Pat. Off.

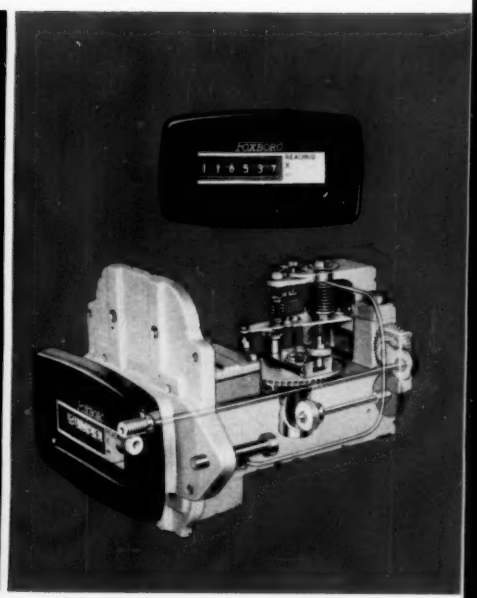
Radioisotopes harnessed for more sensitive measurement and control

FOXBORO SHEET WEIGHT PROFILER

This unique Foxboro development measures and records minute variations in the weight of paper and other web or sheeted materials. Measurement is made automatically by feeding a sample between a radioactive source and an ionization chamber detector. The amount of radiation passing through the sheet into the detector provides a deviation record of the weight of the sheet. This important quality-control measurement is far more rapid and accurate than was possible by any previous method.

The Sheet Weight Profiler is a typical example of how Foxboro engineers turn scientific advancements into better instruments for industry.

For full details, send for Bulletin PD 105-3.



continuous, pneumatic flow totalizing

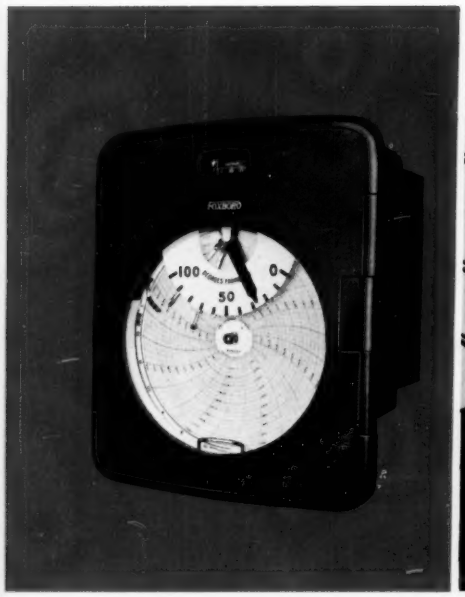
FOXBORO FLYBALL INTEGRATOR

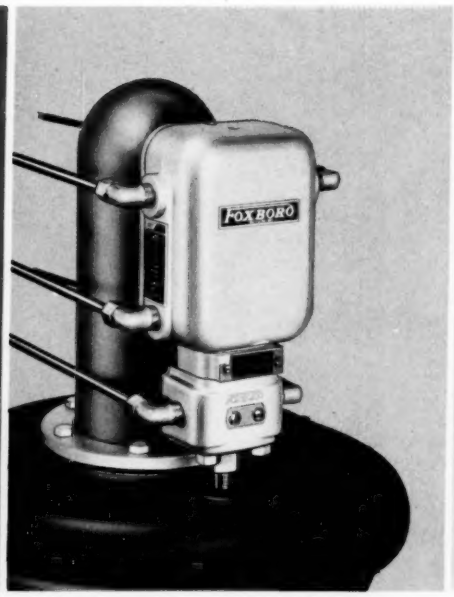
An instrument that counts fluid flow — continuously! That's the achievement of Foxboro's unique "Flyball Integrator."

This totalizer completely eliminates conventional machined cams. Instead, a 3-15 psi air signal from a differential-pressure type flow transmitter is continuously balanced against the centrifugal force of a pneumatically driven turbine. Result — direct reading of actual flow units on the instrument counter. No converters — no intermittent increments.

Because it provides precise linear, continuous integration, the Flyball Integrator is ideal for the accounting of all process fluids and plant services.

For complete details, write for Bulletin 13-23.





"the potentiometer that has NO slidewire"

DYNALOG*
ELECTRONIC RECORDERS
AND CONTROLLERS

Measurement of process variables advanced radically with the development of Dynalog instruments.

These electronic instruments give stepless, continuous balancing, using a friction-free air capacitor instead of the conventional slidewire. There are no high-speed moving parts, no dry cells to replace, no interruptions even for automatic standardizing . . . and no lubrication. Dynalogs combine highest accuracy, sensitivity, and speed of response with unequaled freedom from maintenance.

Resistance, EMF, and capacitance type Dynalog Instruments are available for measuring and controlling temperature, pressure, flow, pH, conductivity, capacity, and many other process variables.

Write for Bulletin 20-10.

*Reg. U.S. Pat. Off.

new dynamic response in flow control . . .

FOXBORO VALVE-MOUNTED
CONTROLLER

Controller-to-valve transmission lag is completely eliminated by this instrument, assuring unsurpassed speed of response — control that's precise, dynamic, smooth.

The M/59 is the *only* pneumatic receiver-controller specifically designed for direct mounting on the control valve motor. This unique force-balance controller has only two moving parts. There's nothing to align, nothing to wear out. A flexure-strip fulcrum eliminates friction and wear of conventional pivots . . . eliminates "conventional" maintenance.

Used with a flow transmitter, the M/59 gives live-action close-coupled response even when the operating panel is as much as 1,000 feet away.

For full information, write for detailed Bulletin 470.

control valve performance matched to control instruments

FOXBORO STABILFLO
CONTROL VALVES

Originally the control valve was considered the weak link in any pneumatic control system. Then Foxboro designed the air-operated Stabilflo control valve, the first valve with wide range, equal percentage V-port design.

These valves give precise, repeatable response for every change in control signal. They have equal percentage flow characteristics with a rangeability of 50 to 1 . . . so essential for maximum performance from proportional controllers.

One of the most copied designs in the industry today, Foxboro Stabilflo Valves are a processor's unqualified assurance of perfectly integrated pneumatic control systems.

For full details, write for Bulletin 5C-10.

differential pressure transmitter unequaled in accuracy, stability, and performance

FOXBORO
d/p CELL* TRANSMITTER

Now and then, a manufacturer develops a product so superior in every respect that it becomes the "standard" for its industry. Such a product is the Foxboro d/p Cell Transmitter.

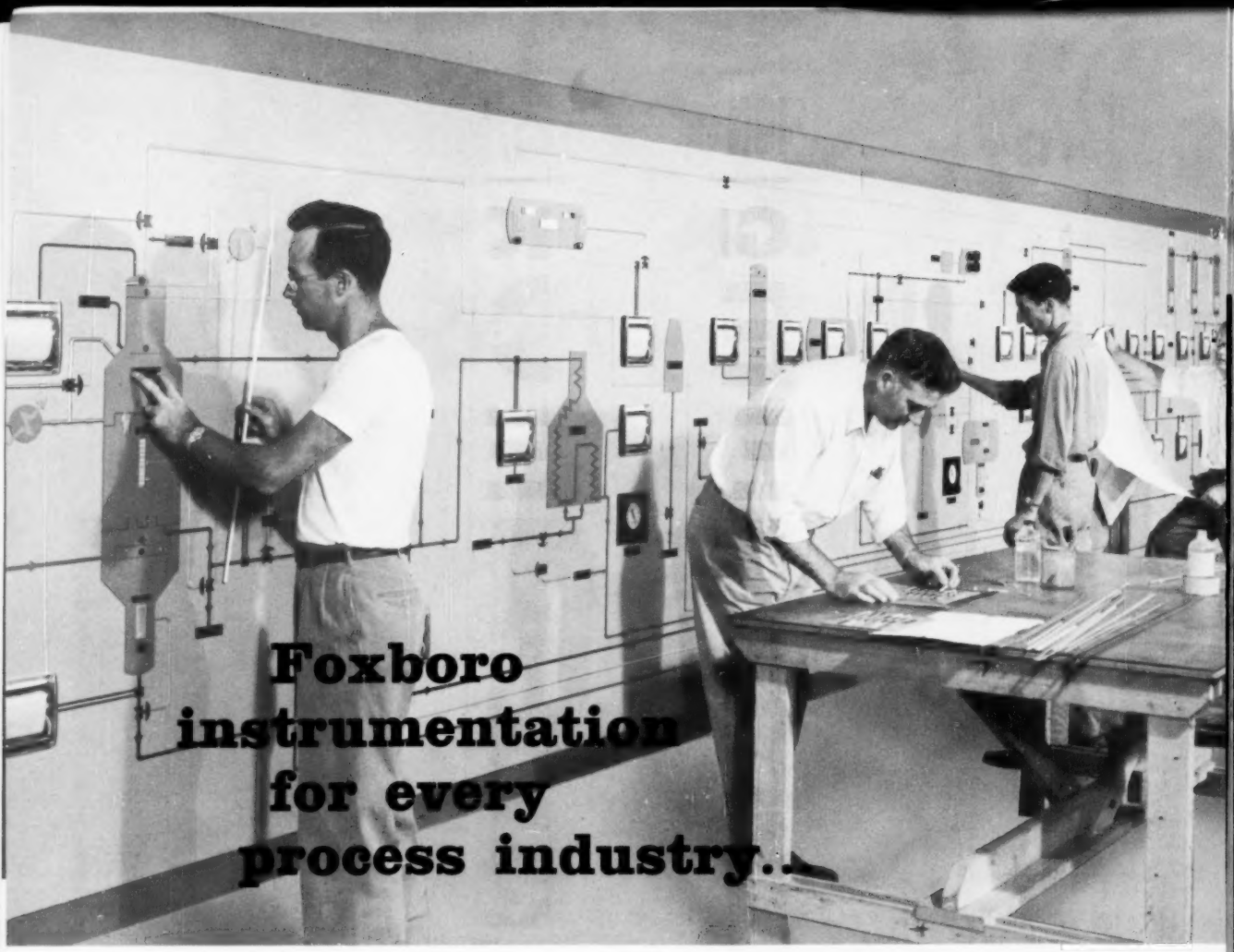
Pioneered 10 years ago, these differential pressure transmitters have established new standards of performance in flow measurement and control. Today, over 75,000 are in use—more than the total of all other makes put together.

d/p Cell Transmitters are now also available for liquid level control; measurement and control of extremely small flows; comparison of process and sample fluids; strain gauge systems; electronic inductive systems; for processes involving high static pressures, or elevated ranges. **Write for Bulletin 13-11A.**

*Reg. U.S. Pat. Off.

Foxboro
makes
a better
instrument

—or Foxboro
doesn't
make it!



INDICATORS
RECORDERS
CONTROLLERS

for

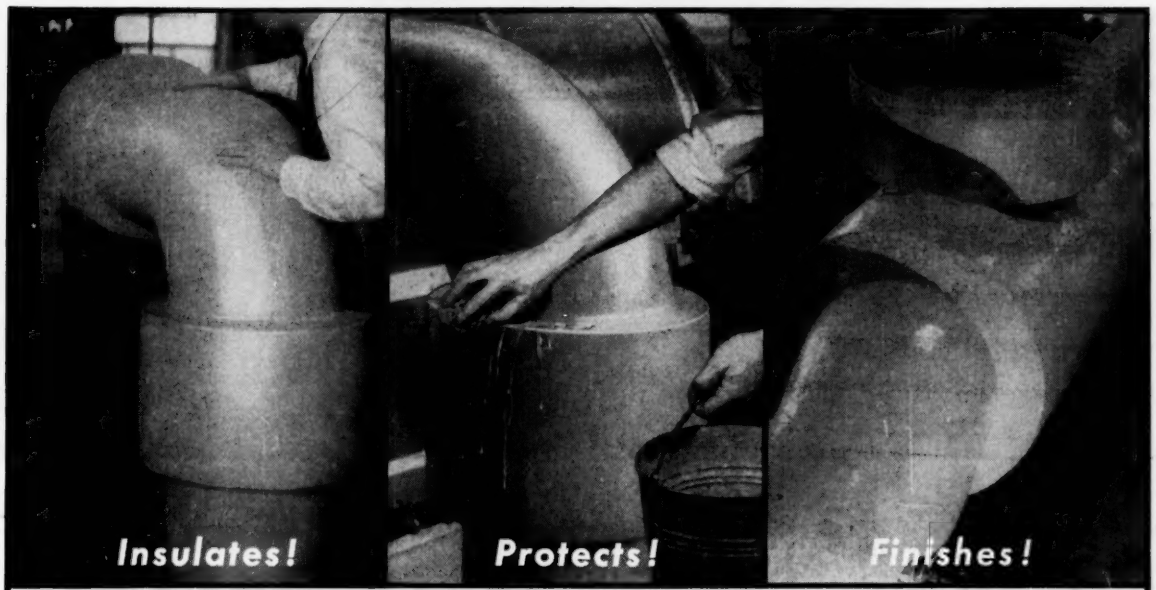
air weight
btu
capacitance
compression
concentration, solution
conductivity, solution
consistency
current—a-c, d-c
density
dew point
displacement
drag
flow
force
gas analysis
humidity
liquid analysis
liquid level
load
moisture content
motion
motor load
operation, schedule
operation, time
oxidation-reduction potential
pH
position
power, electric
pressure
resistance, electric
sheet moisture
sheet weight
specific gravity
speed
strain
stress
temperature
tension
thrust
torque
vacuum
viscosity
voltage
weight

FOXBORO
REG. U.S. PAT. OFF.

THE FOXBORO COMPANY, 54 NEPONSET AVENUE, FOXBORO, MASS., U. S. A.

1 QUICK APPLICATION INSULATES, PROTECTS; FINISHES!

EAGLE-PICHER
ONE-COTE CEMENT



- Saves time, work, money! One quick application provides smooth, light reflectant surface on hot or cold equipment!
- Clean, easy to handle! Just trowel it on—even on irregular areas where application of other insulations is often impractical.
- Highly efficient! Effective insulation at temperatures up to 1000 F.
- For outdoor installations! Quick-setting, withstands rain and moisture two hours after application. Prevents rust!
- For indoor installations! Requires no wire mesh or finishing treatment!

FREE SAMPLE!

Write today!

Prove to yourself, on your equipment, how Eagle-Picher One-Cote Cement can save you time, money and valuable man-hours.

Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.

Since 1843

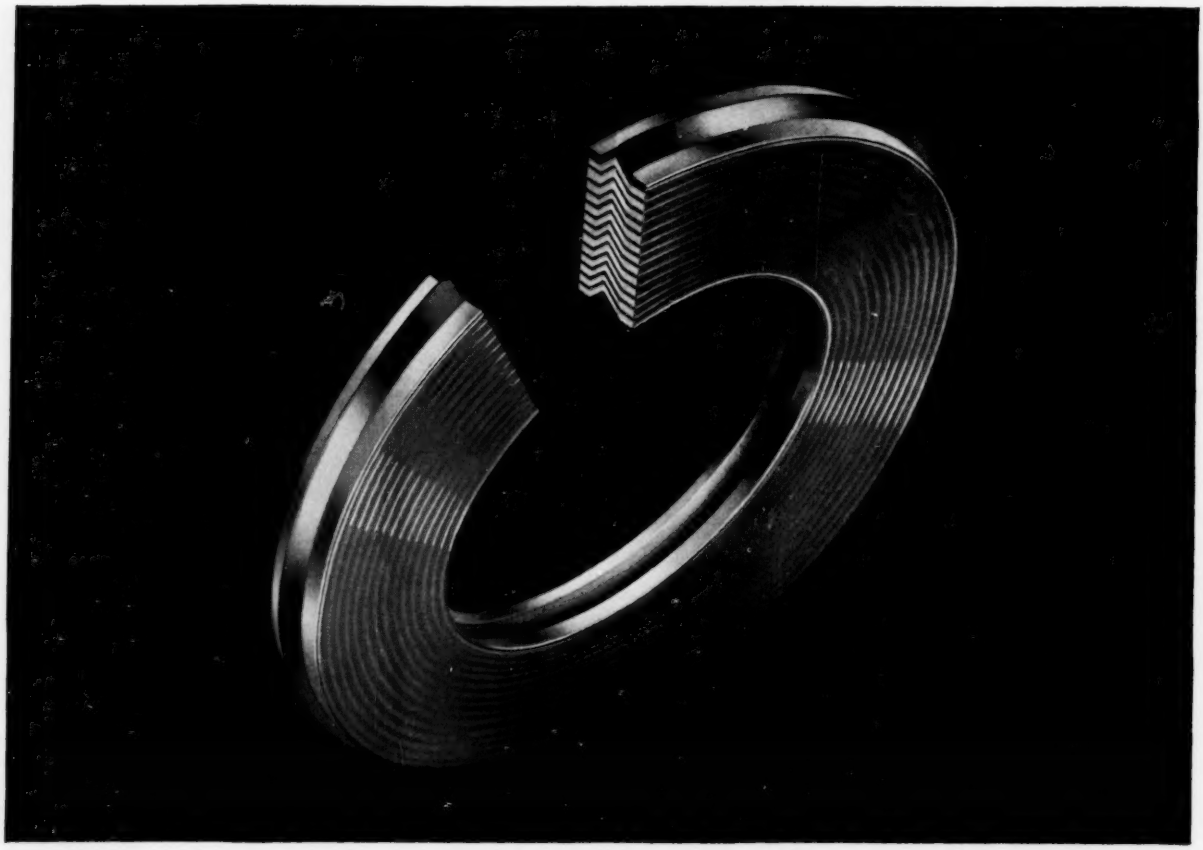
EAGLE EP PICHER

EAGLE-PICHER

The Eagle-Picher Company • General Offices: Cincinnati 1, Ohio

(Member of Industrial Mineral Fiber Institute)

GARLOCK gaskets for



GUARDIAN Gaskets are made in round, oval, square, flat side, diamond and pear shapes in practically any size. Thicknesses ⅛", .175", and ¼" depending on application. Centering devices include a steel ring type to assure accurate positioning and to avoid excessive compression. Also, loop type centering guides are available which fit over opposite bolts.

Teflon* SPIRAL WOUND GUARDIAN† GASKETS for high temperatures and pressures

against steam, oils, gases, liquids, including most chemicals. Constructed of spiral wound strips of "V"-shaped preformed 316 stainless steel alternated with layers of TEFLON. Spring action of V-shaped metal plies provide automatic reaction to compression, internal pressure variations, temperature changes. Provides excellent recovery to accommodate varying service conditions. Available to all ASA standards for pressures to 2500 psi and for temperatures to 450° F with TEFLON (with asbestos filler for temperatures to 1050° F).
Call your Garlock representative, or write for AD-104.

*Dupont Trademark †Garlock Trademark

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Chemical Resistant Piping

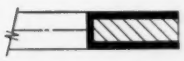
Teflon* JACKETED GASKETS for glass pipe flanges etc.

Resilience and deformability that are lacking in solid all-TEFLON gaskets are amply provided in Garlock TEFLON-jacketed gaskets. Fillers are available in practically any material for any application. Once the basic design has been selected, then the filler material and thickness are considered: rubber, asbestos, cork, corrugated stainless steel, etc. Call your Garlock representative or write for Garlock Folder AD-154.

Gaskets of TEFLON are another important part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line. That's why your Garlock representative can give you unbiased recommendations.

BASIC DESIGNS

Slit Envelope. Flat Teflon stock slit from outside diameter to within ⅛" of inside diameter.



Milled Envelope. Flat Teflon stock machined from outside diameter to within 1/32" of inside diameter. Provides flush surface with pipe I.D. Reduces impedance to process flow.

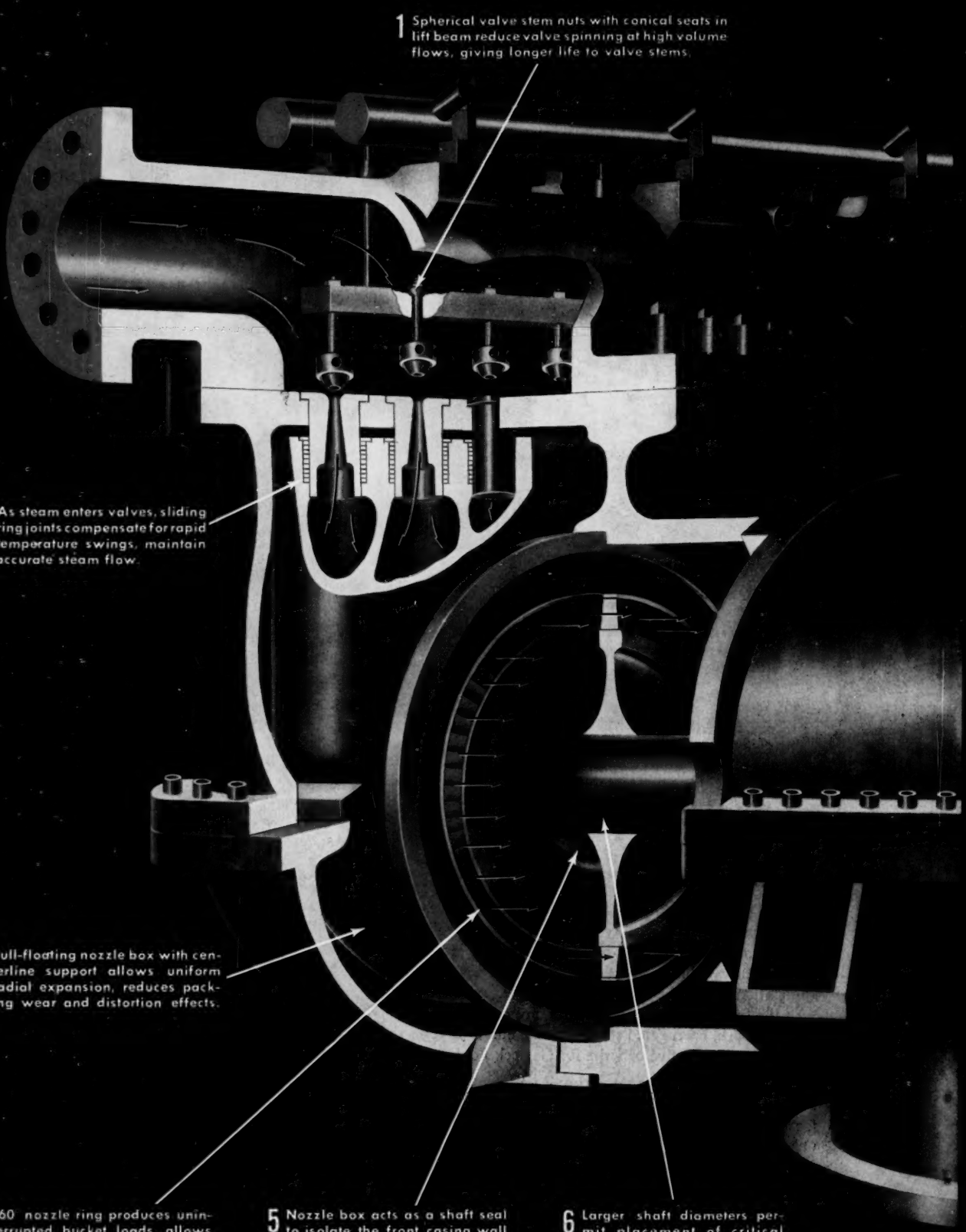
Formed Shield for large diameters and irregular opening such as elliptical manholes.

Double Jacket. Two jackets overlapping to protect O.D. as well as I.D. For glass-lined steel nozzles.

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

PLASTICS DIV.: UNITED STATES GASKET CO., CAMDEN, N. J.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.


1 Spherical valve stem nuts with conical seats in lift beam reduce valve spinning at high volume flows, giving longer life to valve stems.
2 As steam enters valves, sliding ring joints compensate for rapid temperature swings, maintain accurate steam flow.
3 Full-floating nozzle box with centerline support allows uniform radial expansion, reduces packing wear and distortion effects.
4 360 nozzle ring produces uninterrupted bucket loads, allows shorter, stronger buckets, more reliable operation at high speeds.
5 Nozzle box acts as a shaft seal to isolate the front casing wall from high pressure steam, permits shorter shaft span.
6 Larger shaft diameters permit placement of critical speeds and step-thrust effect.

New full-circle nozzle ring helps give more

PROFITABLE POWER

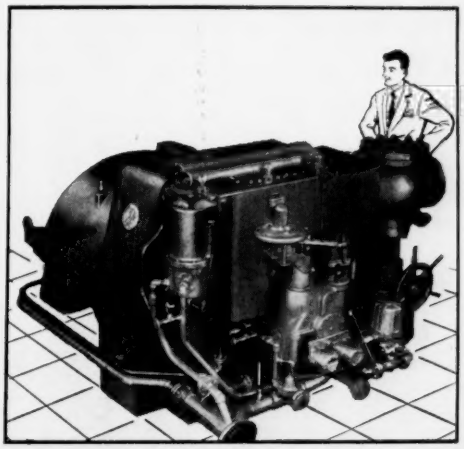
at high ratings, high speeds with General Electric turbines

The new 360° nozzle ring available on General Electric high-volume flow turbines allows horsepower ratings to 15,000 and speeds to 12,500 rpm without appreciable increase in turbine dimensions. Now you can drive high-speed compressors more efficiently with powerful General Electric mechanical drive turbines.

Greater reliability is realized in these G-E high-speed turbines because the unique 360° nozzle ring distributes power to all of the buckets. This reduces bucket loading and increases turbine reliability.

Turbine maintenance is greatly simplified because there are few high-pressure joints and no jumper pipes in this one-piece internal shell.

Ask your nearby G-E Apparatus Sales Office for details on how mechanical drive turbines can help bring profitable power to your high-speed applications—or write to General Electric Company, Section 241-11, Schenectady 5, N.Y.



THIS G-E TYPE DRV MULTIVALVE mechanical drive turbine meets stiff process requirements under conditions of frequent load fluctuations, or where there is large volume steam flow.

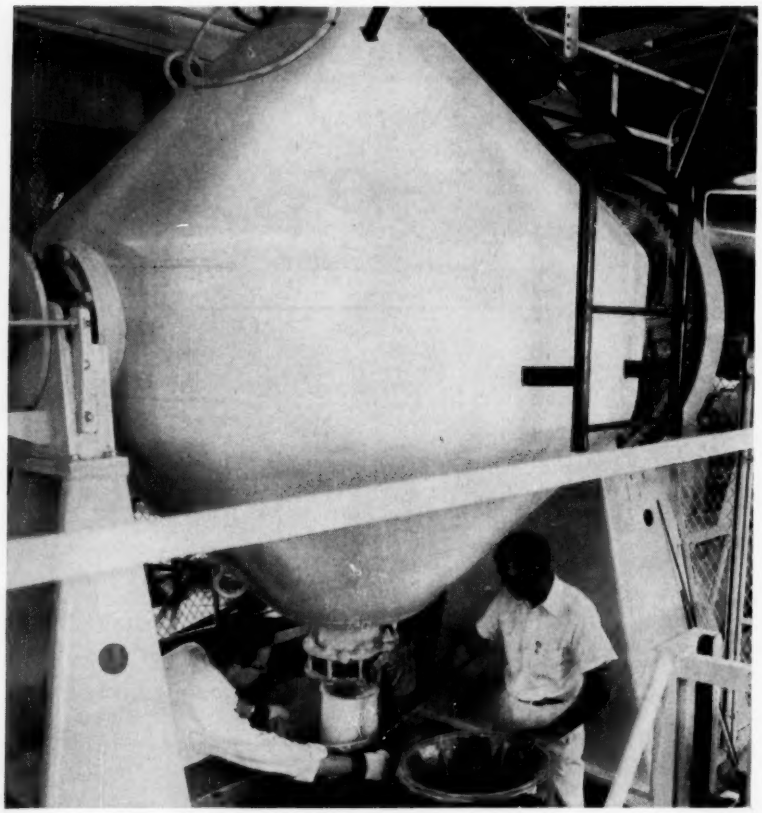
Progress Is Our Most Important Product

GENERAL ELECTRIC

Cut drying time up to 90%. For information on Pfaudler glassed-steel dryer-blender, ask for Data Sheet 26.

Pfaudler

Pfaudler Corrosioneering News Published by The Pfaudler Co., a division of Pfaudler Permutit Inc., Rochester, N.Y.



Eliminates intermediate materials handling. Product goes from process into the Pfaudler conical dryer-blender, and then directly into package. Dried and blended in one operation.

Corrosion resistance of glassed steel unimpaired by gamma radiation

No adverse effects could be detected from the exposure of glassed steel to gamma radiation in tests recently completed by Pfaudler in cooperation with Oak Ridge National Laboratory and other installations.

Preliminary evaluations have been completed on the test which exposed glassed samples to a total dose of 10^{10} roentgen from spent fuel elements.

Glassed steel is being considered as a construction material for chemical processing involving nuclear energy wherever corrosive conditions are particularly severe and ease of decontamination is important.

Probable uses of glassed steel in this vast field include storage of acids and other materials which may or may not be radioactive, storage and disposal of radioactive wastes, and chemical processing of highly radioactive and corrosive materials.

Both mechanical and corrosion tests indicate that Pfaudler glass is unaffected by gamma radiation up to 10^{10}r, although a color change does occur.

A larger test program is now under way to follow up these early results and to determine more conclusively the effect of radiation on glassed metals.

Now Upjohn saves 32 hours drying 2500 pounds of Orinase

Sixteen hours are all it takes for the Upjohn Company to dry and blend 2500 pounds of Orinase in the Pfaudler conical dryer-blender.

It used to take forty-eight hours to dry that much of Upjohn's oral antidiabetic in two straight vacuum dryers.

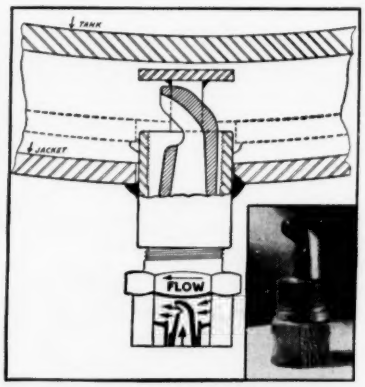
Upjohn says it also saves eight hours a week in materials handling time with the new dryer.

Since it's a pharmaceutical, the product poses a purity problem which is nullified by the noncontaminating glassed-steel construction of Pfaudler dryer-blenders.

Other companies, many handling corrosives, report similar savings, some of them cutting drying time by as much as 90%. The smooth glassed surfaces of the drying chamber are insensitive to all corrosives except hydrofluoric acid and hot alkalies above pH12.

The Pfaudler design offers a solid, one-piece drying chamber which offers maximum strength and drying area unbroken by joints or clamps. The vacuum exhaust tube is centrally located for the most efficient vapor removal.

There's much more about the Pfaudler dryer-blender that proves its efficiency of operation over other designs . . . all of it in Data Sheet 26 which you'll find offered in the coupon.



New data on turbulent flow in reactor jackets

Capacities and characteristics of the Pfaudler Agitating Nozzle and its superiority over the commonly used spiral jacket are discussed in a new

Corrosioneering News

Quick facts about services and equipment available to help you reduce corrosion and processing costs.

Bulletin No. 950. Working basis for the agitating nozzle is the use of kinetic energy. This is available through the pressure and volume of the heating or cooling liquid delivered to the reactor as a direct means of producing circulatory movement of entire contents of jacket. Capacity chart and typical hookup of nozzles are shown. Method of selecting nozzles is fully covered. Ask for Bulletin No. 950.

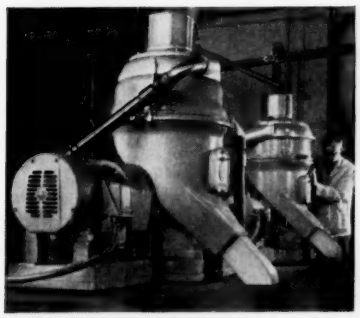
Pre-test lab takes all the gamble out of equipment buying

Whenever you engineer a process involving corrosives you're naturally a little more selective than you might be otherwise.

One way to satisfy this care in selection is to take advantage of the Pfaudler pre-test lab.

We'll run a sample of your product or materials through the equipment here at our lab, do an analysis, and show you what you can expect on the production line.

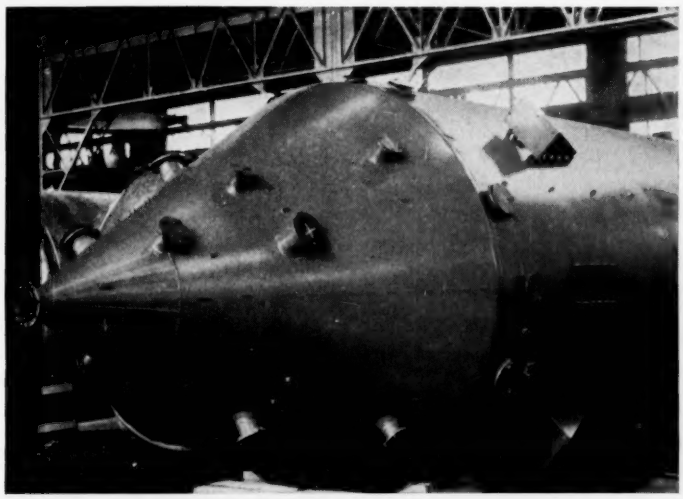
Our lab is equipped with 10, 30, and 300 gallon glassed-steel reactors, a two-foot glassed-steel conical



dryer-blender, model agitation units, heat transfer testing equipment, two self-desludging Titan centrifuges, wiped-film evaporators, and a complete pilot assembly for distillation and fractionating.

Any testing done is, of course, completely confidential. It can sometimes even be arranged for you to rent certain of the equipment for pre-testing in your own plant.

Either way you know exactly how everything works, before you make a purchase. Ask your Pfaudler representative for a pre-test questionnaire.



"Is Pfaudler making Sputniks?"

—This was an oft heard question recently from visitors to our Rochester plant. What they saw was this unusual new cone bottom reactor we fabricated and glassed for a leading chemical producer. All those nozzle openings on the conical surface made glassing a little "touchy," so it took us a little longer than with standard models.

The vessel is 388 inches long with a 138-inch OD, and will be used for storing and purging polymer chips at 160°F. An internal column does the purging with an inert gas.

Why do we show it here? To suggest that we can put the corrosion resistance of Pfaudler glass to work on more than conventional reactors, storage tanks, columns, etc.

THE PFAUDLER CO., a division of PFAUDLER PERMUTIT INC.
Dept. CE-58, Rochester 3, N.Y.

Please send information on ☐ Data Sheet 26 Conical Dryer-Blenders; ☐ Bulletin 950 Agitating Nozzles; ☐ Pfaudler Buyer's Guide.

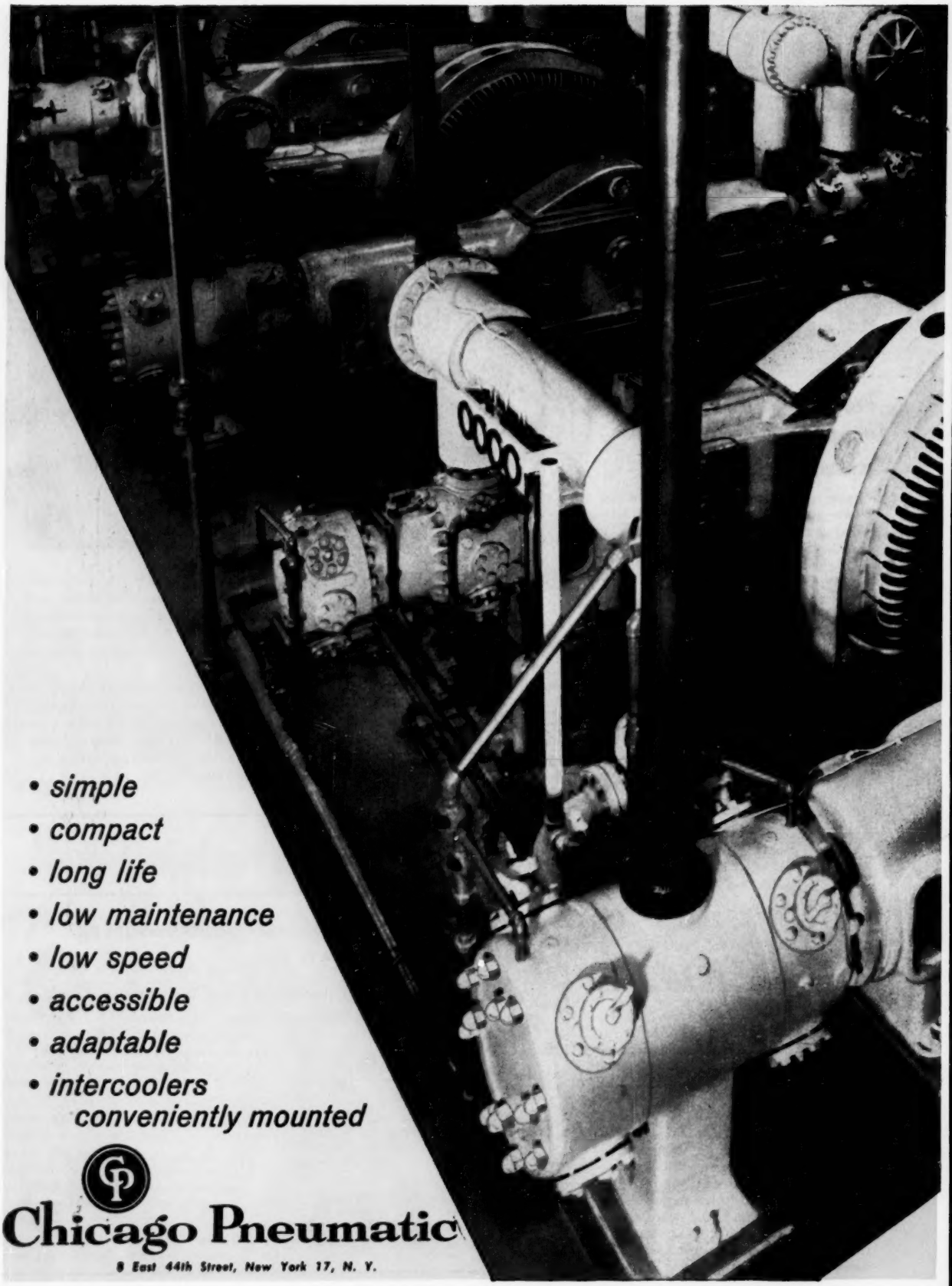
Name .....

Title .....

Company .....

Address .....

City ..... Zone ..... State .....


• simple
• compact
• long life
• low maintenance
• low speed
• accessible
• adaptable
• intercoolers
conveniently mounted
Chicago Pneumatic
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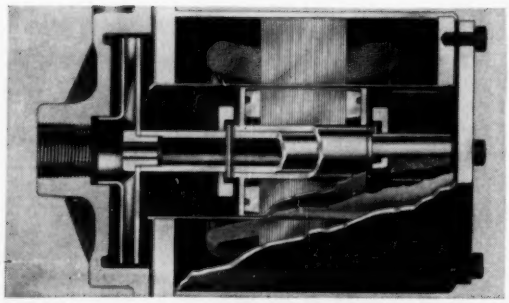
Class H-CE five-stage compressors, two of several on the line 24 hours a day.
Four-stage Class H compressors meet air liquefaction demands in a steel plant.
• FOR PRESSURES TO 15,000 PSIG
• SIZES 200 to 2000 HP
(other CP Compressor models available in sizes up to 5000 hp)
CP
HORIZONTAL DUPLEX
motor-driven
COMPRESSORS
AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS



WHAT'S EVEN MORE CORROSION-RESISTANT than stainless? Republic Titanium. Maximum corrosion-resistance plus an exceptionally high strength-to-weight ratio are major reasons for its use in this seal-less, leak-proof centrifugal pump made by Chempump Corporation, Philadelphia, Pennsylvania. The pump handles such corrosive liquids as chlorine dioxide. All wetted parts are made from Titanium. Chempump's exclusive design makes it possible and *economical* to use Titanium for these vital parts. Mail coupon for more facts on Republic Titanium.

EXCELLENT CORROSION-RESISTANCE of Republic SRK Plastic Pipe provides major savings in chemical piping installations. SRK needs no maintenance. Replacement costs due to corrosion are eliminated. SRK's extreme toughness shrugs off mechanical abuse. Republic SRK is lightweight, easy to carry. It cuts readily with handsaw or hacksaw—is easily joined with brush-applied solvent and sleeve-type fittings. SRK is available in a range of working pressures and in sizes ½" through 6". Send coupon for literature.

STAINLESS STEEL for Strength, Safety, Corrosion-Resistance

What appears to be a delicately-thin piece of gauze is actually a tough, strong, lightweight stainless steel surgical screen. It is being inserted to strengthen weakened muscle wall.

The same chemical and physical properties that make stainless steel safe for use in the human body can be applied economically to your processing operations to safeguard product quality and purity.

Republic ENDURO Stainless Steel is inert to most chemicals and chemical compounds. It does not add unwanted elements. It never takes anything away. Quality and purity of the product being processed is maintained at the highest level.

ENDURO is solid stainless steel. There is no applied surface to crack, chip, flake, or peel away. Its smooth, hard, dense, sanitary surface offers little foothold for contaminants. Equipment made of ENDURO is amazingly easy to clean and keep clean. Maintenance is held to an absolute minimum.

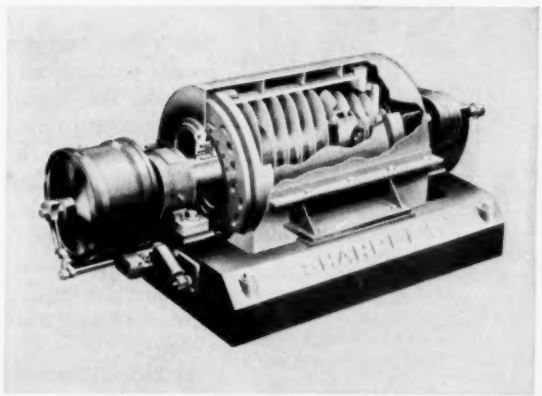
Strength, heat-resistance, and corrosion-resistance at temperatures from below freezing to blistering hot are further advantages of ENDURO that you can be enjoying now. Contact your equipment supplier for more facts. Or send us the coupon. Expert metallurgical assistance available without obligation.

This example of the advantages of stainless steel is brought to you by Republic Steel in behalf of the stainless steel equipment manufacturers and the Republic Stainless Steel distributors—your local steel service centers.

REPUBLIC STEEL

WORLD'S WIDEST RANGE OF STANDARD STEELS AND STEEL PRODUCTS

STAINLESS STEEL in the SUPER-D-CANTER centrifuge made by The Sharples Corporation, Philadelphia, Pennsylvania, aids in economical and continuous recovery of valuable solid products from slurries and suspensions. Flights of an internal screw conveyor mechanism, shown at right in cutaway view, must be welded to the hub. Use of low carbon stainless steel eliminates necessity for heat treating after welding. Yet, maintains desired corrosion-resistance. Conveyor, discharge covers, and all other welded parts are of Type 347 stainless steel. Bowl is constructed of Type 316 stainless, stabilized.



STRENGTH AND SAFETY of Republic Steel Drums assure complete protection of your product during handling, shipping and storing. Republic's full line includes: Light Gage Class I.C.C.—17E, 17H, 17C, 6J, and Heavy Gage Class I.C.C.—5, 5A, 5B, 5C, 17F, and certain I.C.C.—6 Series. Drums are available in 55-, 30-, and 20-gallon capacities. Choose from ENDURO Stainless Steel, hot dipped galvanized steel, hot dipped tinned steel, plain or lacquer lined. Choice of gages to meet all shipping requirements. Send coupon for complete details.

REPUBLIC STEEL CORPORATION
DEPT. CE-5299
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send me literature on:

☐ ENDURO® Stainless Steel ☐ Steel Drums
☐ SRK Plastic Pipe ☐ Titanium

Name _____ Title _____
Company _____
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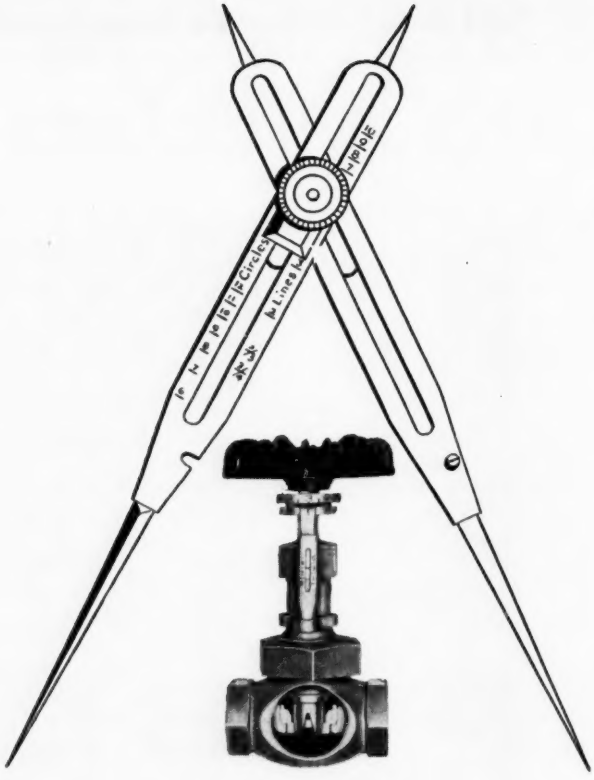


PROPORTIONER

controls flow to save for you

The V-port disc in all Hancock "Flocontrol" Valves insures proportional flow throughout the entire lift of the stem. They are valves that help you achieve uniform product quality through closer control, save steam and fuel on process work, and cut maintenance costs.

"3 in 1" valve design combines variable orifice with shut-off and micrometer dial and pointer. The valve opening can be set within 1/10 turn of the handwheel —you can duplicate all settings easily, instantly. No shut-off valve required—flow is in a straight line, with separate shut-off seating surface located away from the V-ports.

Hancock "Flocontrol" Valves are available in Bronze and Steel to meet the most demanding services. Ask your industrial supply distributor for details.

Hancock "Flocontrol" valves assure positive pinpoint control—eliminate all guesswork.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

HI-58

HANCOCK "FLOCONTROL" VALVES

A product of

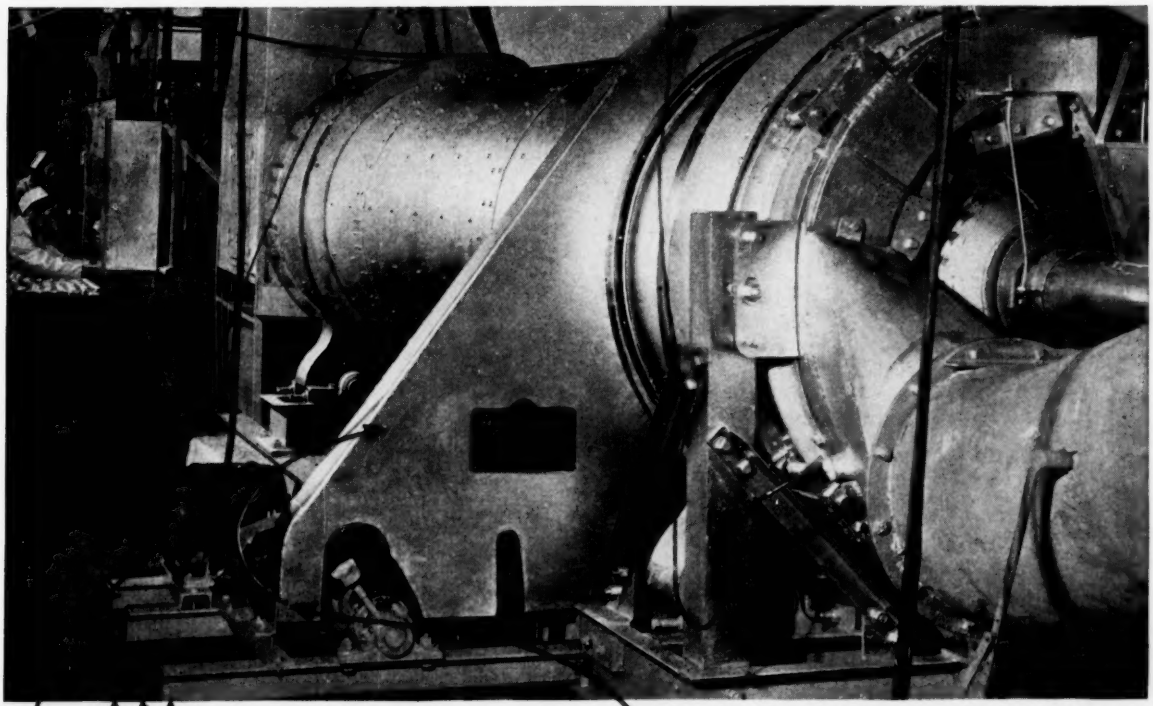
MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts

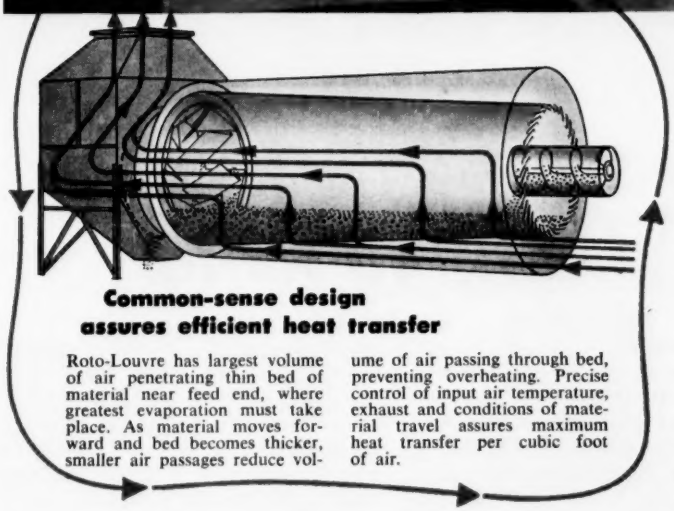
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

Why the LINK-BELT Roto-Louvre dryer can

mass-produce your product with laboratory accuracy



Where rapid, continuous processing and product uniformity are essential—as in processing organic materials (above)—Roto-Louvre's efficient heat transfer excels.



Common-sense design assures efficient heat transfer

Roto-Louvre has largest volume of air penetrating thin bed of material near feed end, where greatest evaporation must take place. As material moves forward and bed becomes thicker, smaller air passages reduce volume of air passing through bed, preventing overheating. Precise control of input air temperature, exhaust and conditions of material travel assures maximum heat transfer per cubic foot of air.

Gentle handling controls quality as precisely as your pre-forming methods

IF you find your product's quality varying seriously from test sample results, check your dryer. Chances are, you need the precise control and uniform processing the Link-Belt Roto-Louvre offers.

This compact, effective machine introduces dry, heated air through ever-changing channels, assuring uniform drying of the entire surface of each particle. Even friable materials or those tending to case-harden are handled successfully without sacrificing thermal efficiency or volume.

Roto-Louvre is one of several types of Link-Belt dryers. Our engineers will recommend the right one for your needs . . . or test a sample of your product in our modern laboratory.

LINK-BELT

DRYERS • COOLERS • ROASTERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,983

LINK-BELT COMPANY
Prudential Plaza, Chicago 1, Ill.

Please send me 20-page Roto-Louvre Book 2511.

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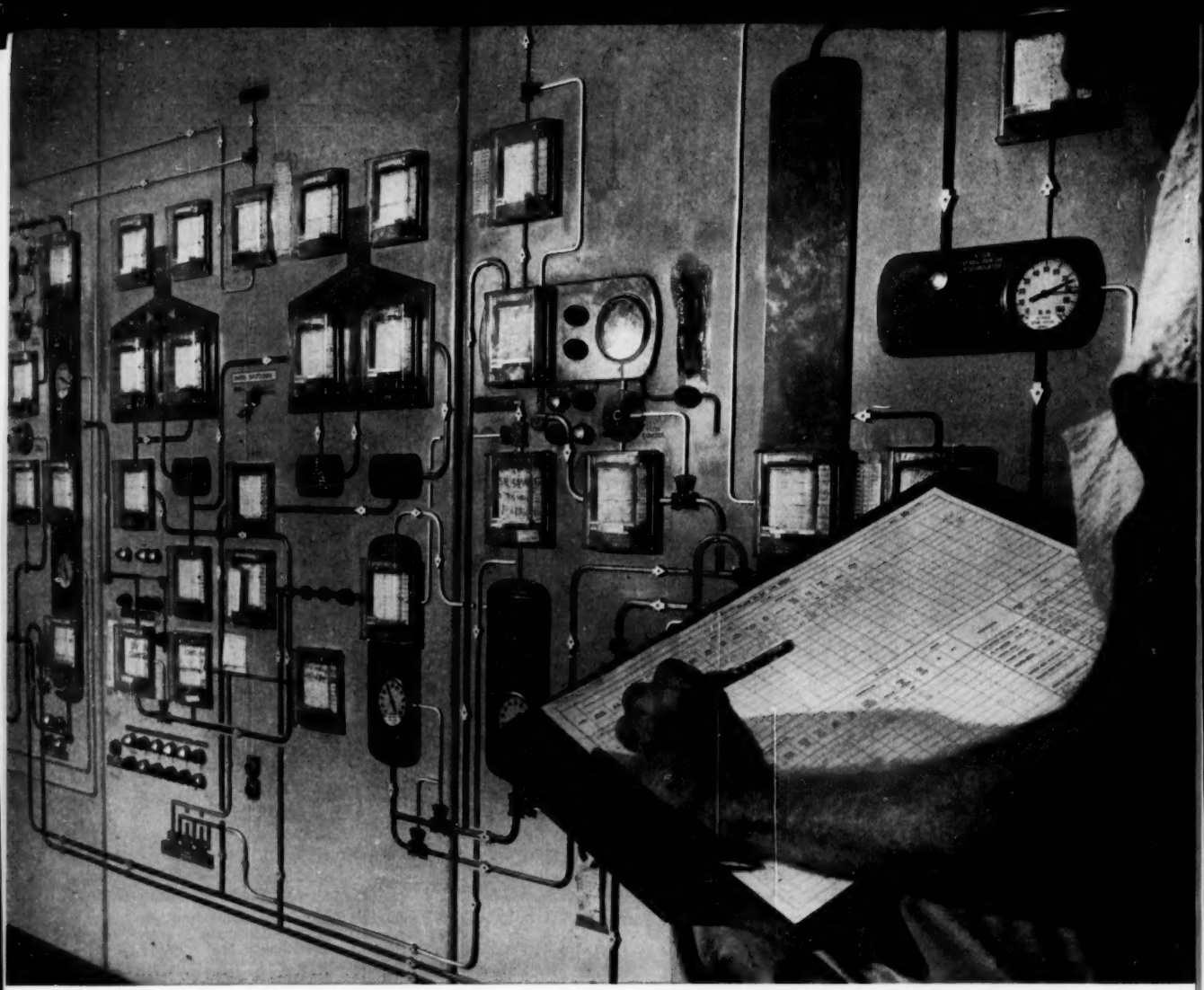
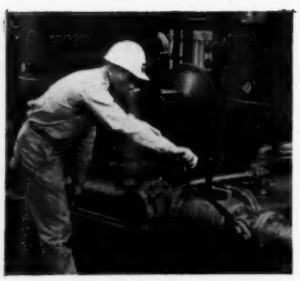


Typical Air-Operated Instrument Panel

To keep down-time down . . .

Come to Kemp



Semi-automatic Kemp Convection Dryer protects vital instruments at Grace Chemical's Woodstock, Tennessee plant. Unit operates around the clock preventing corrosion and line freezes with a bare minimum of attention.

A Kemp gas dryer in your operation can put an end to many costly shut-downs by protecting air-operated instruments from corrosion and freezing or jamming . . . efficiently drying inert gases for purging and blanketing . . . or drying atmospheres and process gases in hundreds of other applications. Operations are faster and safer, with better quality control and frequently reduced costs.

And Kemp dryers, operating on the dynamic drying principle, are noted for dependable operation. Rugged Kemp dryers will do your drying job around the clock, month after month, without stoppages or major maintenance. Kemp design reduces utility and operating costs, uses desiccants more efficiently, and eliminates process gas contamination. Units dry to lower dewpoints to give your processes and instruments highest possible protection.

Call your Kemp Representative, listed in the Chemical Engineering Catalog, for detailed information and a no-obligation survey of your dryer needs. Or write direct, for Bulletin D-100. The C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Md.

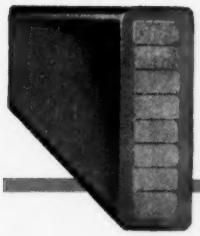
Kemp Convection Dryers

Kemp Inert Gas Generators

KEMP OF BALTIMORE

Kemp Industrial Carburetors

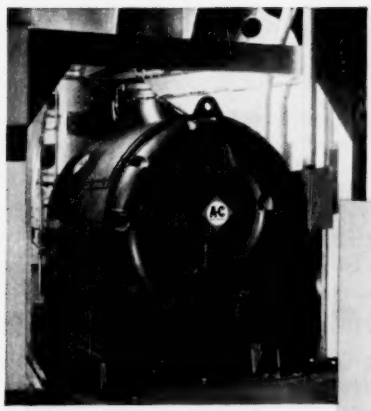
Kemp Oriad Dryers



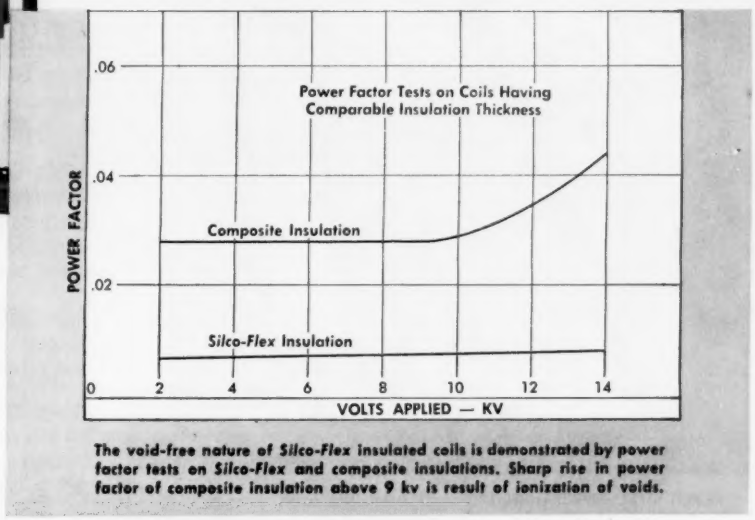
Super-Seal...

motor with void-free insulation

New motor withstands chemicals, moisture, heat, abrasion...



revolutionizes motor protection practices in chemical and petroleum industries



The void-free nature of *Silco-Flex* insulated coils is demonstrated by power factor tests on *Silco-Flex* and composite insulations. Sharp rise in power factor of composite insulation above 9 kv is result of ionization of voids.

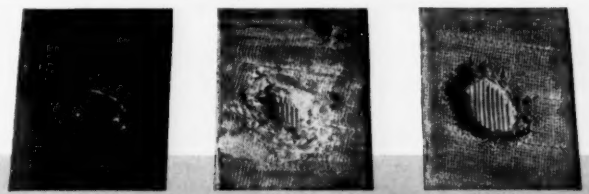
Remarkable new insulating systems combined with advanced mechanical features provide a completely new concept in motor protection — the *Super-Seal* motor. This revolutionary new motor gives you complete protection from moisture, corrosion and contaminants, even with so-called drip-proof motor enclosures.

New motor is protected with:

Silco-Flex stator coil insulating system. A homogeneous, void-free dielectric barrier combining resilience with moisture, heat and abrasion resistance. *Silco-Flex* insulation is specially designed for most corrosive or chemical atmospheres.

Integrated field coils in synchronous machines are completely sealed against contaminants, bonded and locked against mechanical forces.

For additional information, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.



Note difference in abrasion! Insulation shown after sandblasting for one minute with 90-grit aluminum oxide and 100-psi air from distance of six inches.

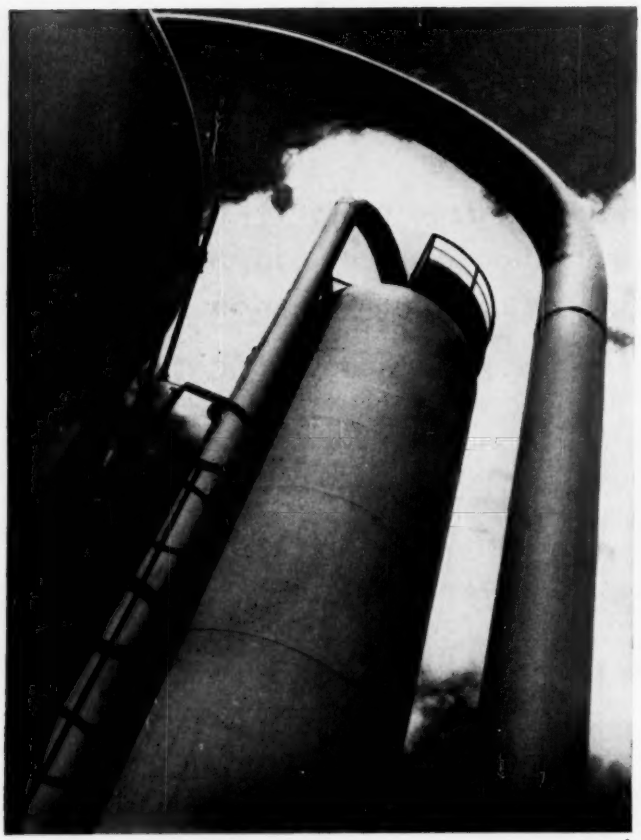
Super-Seal and Silco-Flex are Allis-Chalmers trademarks

ALLIS-CHALMERS

A-5701

Operating at Increased Temperatures and Pressures?

Special Armco Stainless Steels Can Help Keep Your Plant "On Stream"



If the increased temperatures and pressures required for higher efficiencies are giving you material-selection and maintenance problems, try the solution found effective by many design and plant engineers . . . special Armco Stainless Steels. For severe operating conditions, they provide unusual combinations of corrosion- and oxidation-resistance, high temperature strength and hardness, plus excellent fabricating characteristics.

Advantages of Special Armco Grades

Here are a few of the unique stainless steels produced by Armco and the reasons why they can help you avoid unscheduled shutdowns:

Armco ELC Stainless — Extra-low carbon variations of Types 304, 316, and 317. Provide low-cost insurance against intergranular corrosion due to carbide precipitation adjacent to welds. Ideal for field welding.

Armco 17-4 PH and 17-7 PH Stainless — Precipitation-hardening grades with unusually high strength and hardness up to 900 F; resistant to galling and abrasion. Useful for pump shafts, springs, valve diaphragms and stems, and high strength bolts.

Armco 17-14 Cu Mo Stainless—An economical corrosion-resistant material for long-time service up to 1500 F. Has exceptionally high rupture and creep strength.

Armco 22-4-9 Stainless—Ideal for applications requiring high hardness and strength as well as resistance to erosion, corrosion and oxidation at temperatures from 900 to 1600 F.

Give your chemical processing equipment operational and maintenance advantages by specifying Armco Special Stainless Steels. Supplemented by Armco's complete line of standard stainless grades, they help you do the job at least cost.

For additional information, just fill out and mail the coupon.

ARMCO STEEL CORPORATION, 1238 Curtis Street, Middletown, Ohio

Send me additional data on the Armco Stainless Steels for chemical processing equipment.

☐ Armco ELC ☐ Armco 17-4 PH and 17-7 PH
☐ Armco 17-14 Cu Mo ☐ Armco 22-4-9

Name_____

Company_____

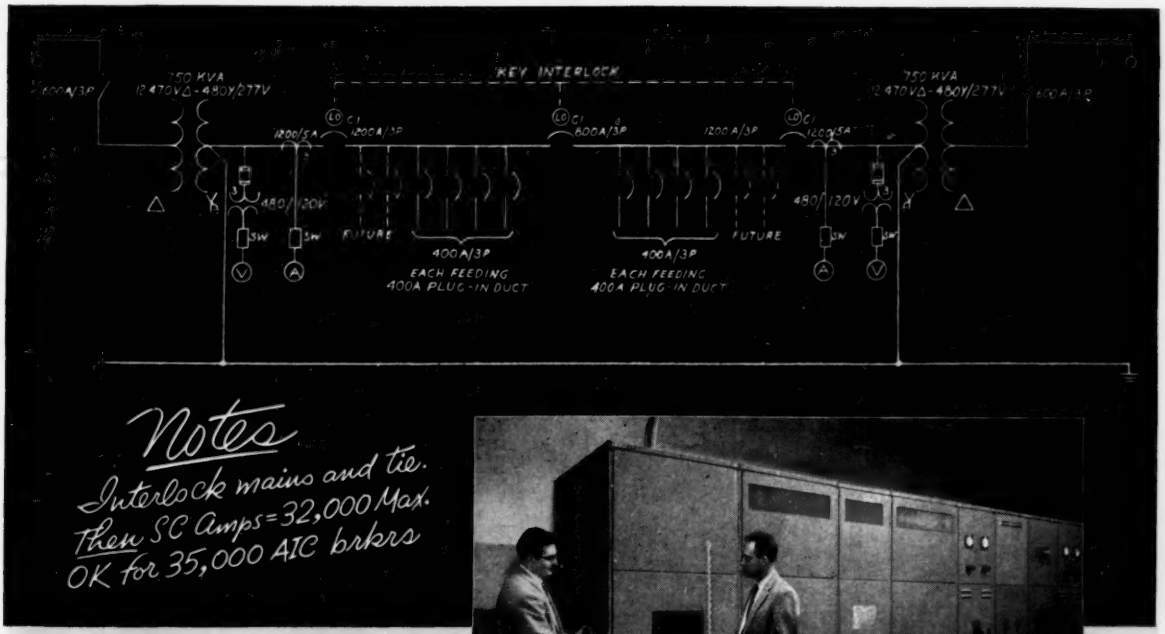
Street_____

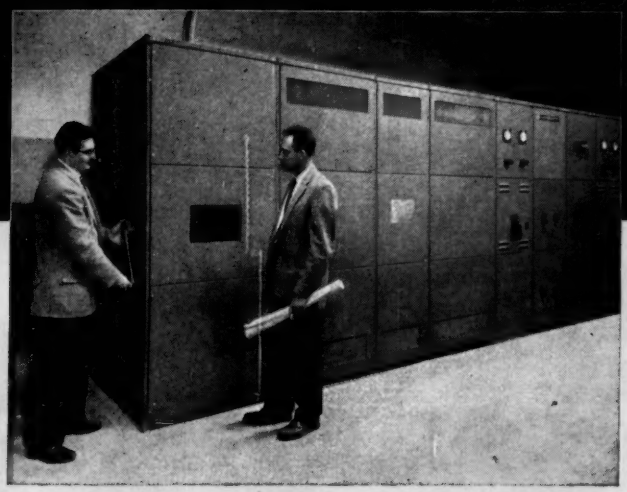
City_____ Zone____ State_____

ARMCO STEEL

ARMCO STEEL CORPORATION • 1238 CURTIS STREET, MIDDLETOWN, OHIO

SHEFFIELD DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION





In Unit Substations COORDINATED DESIGN

Cuts Costs and Saves Space!

Square D designs and builds a complete line of substations for any application, indoor or outdoor—with dry or liquid-filled transformers—with large air breakers or molded case breakers—with motor control units.

A typical example is this 1500 KVA double-ended unit substation, designed to meet the special requirements of a Lexington, Kentucky, plant. Flexibility for future expansion and complete safety without service interruption were essential. The following features are incorporated in the unit:

Main breakers are 1200-ampere air circuit breakers

Feeder breakers used to feed Square D plug-in duct, are molded case breakers

Tie-in breaker is key-interlocked to permit tying units together when operating on one transformer in an emergency

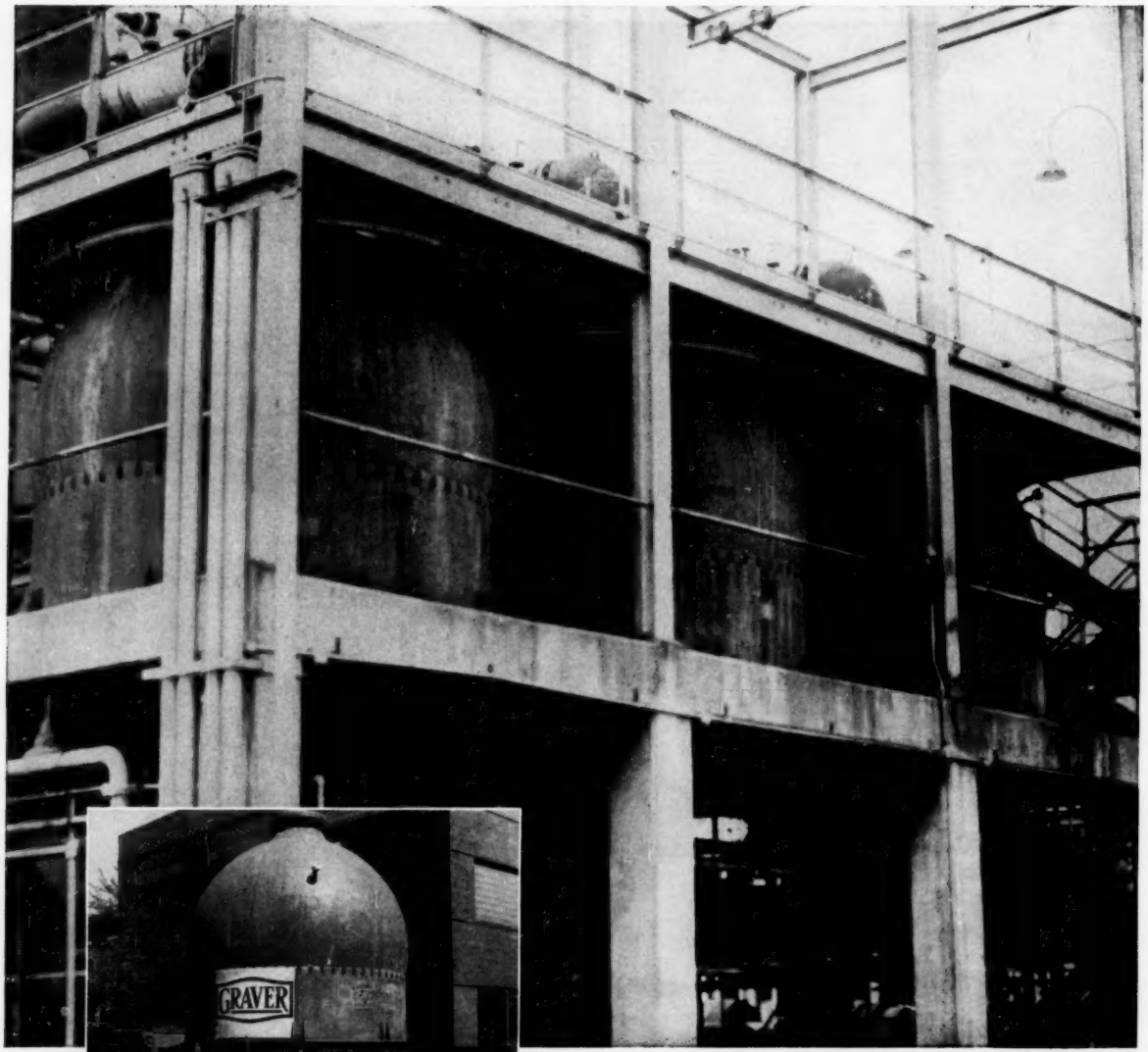
Interrupting capacity of all molded case breakers exceeds the total maximum available short circuit current, including 100% motor contribution

By the proper application of molded case breakers, Square D engineers achieved a substantial reduction in both the size and the cost of the substation—and with no sacrifice in performance.

For the complete story of Square D coordinated design, write Square D Company, 6060 Rivard Street, Department SA, Detroit 11, Michigan.

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY



Stainless-Lined . . .

TO ARREST HIGH-TEMPERATURE CORROSION

Among the many spherical structures Graver has fabricated in its hundred year history, these reactors for Socony Mobile Oil Company's refinery at East Chicago, Indiana, are typical of the craftsmanship required to assure long, trouble-free life under sustained high temperature and high pressure. To minimize corrosion at operating temperatures of 980° and 600 psi, Type 321 stainless was used for the inner liners, catalyst supports, inlet vapor distributors and drain scoops. The shells were made from 1¾" A201 Grade B firebox quality carbon steel to which an intermediate lining of concrete was applied. Graver's skills in working with all types of alloys assure long life for processing equipment that must operate continuously under high temperatures and high pressures.

GRAVER®
ALLOY DIVISION

Building for the Future on a Century of Craftsmanship in Steels and Alloys

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EAST CHICAGO, INDIANA • New York • Philadelphia
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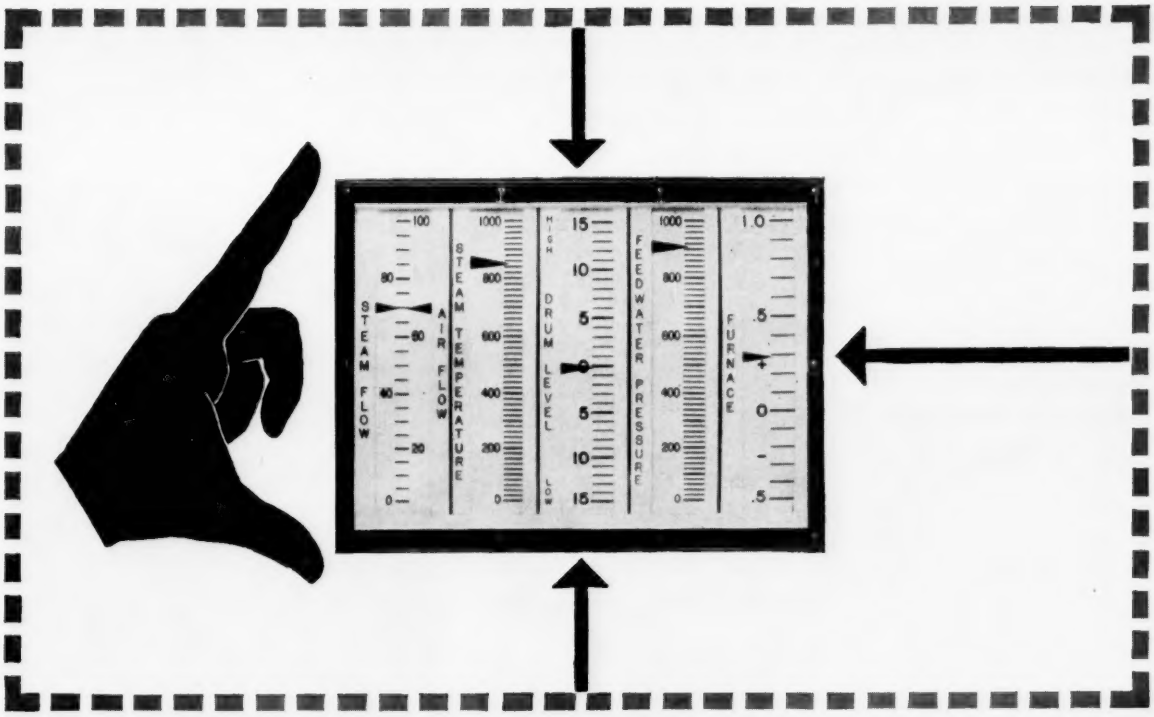


Get big-gauge accuracy and sensitivity with

Republic's V5 Series of Compact Measuring Instruments

Two sets of Republic V5 gauges mounted on a modern console-type boiler control panel. Gauges match the compactness of the other instruments, yet are easy to read—even from a distance.

Republic V5 gauges feature full-sized diaphragms, bellows and helixes, yet require only one-fourth as much panel space as ordinary instruments. *Eight* V5 gauges can be mounted in a single bank requiring only about 14″ x 6½″. This compactness makes them ideal for console or graphic type panels. Each V5 gauge is an independent unit, which may be removed or replaced without disturbing adjacent gauges. Each 5″ vertical scale is illuminated from the rear for top readability—even from a distance.

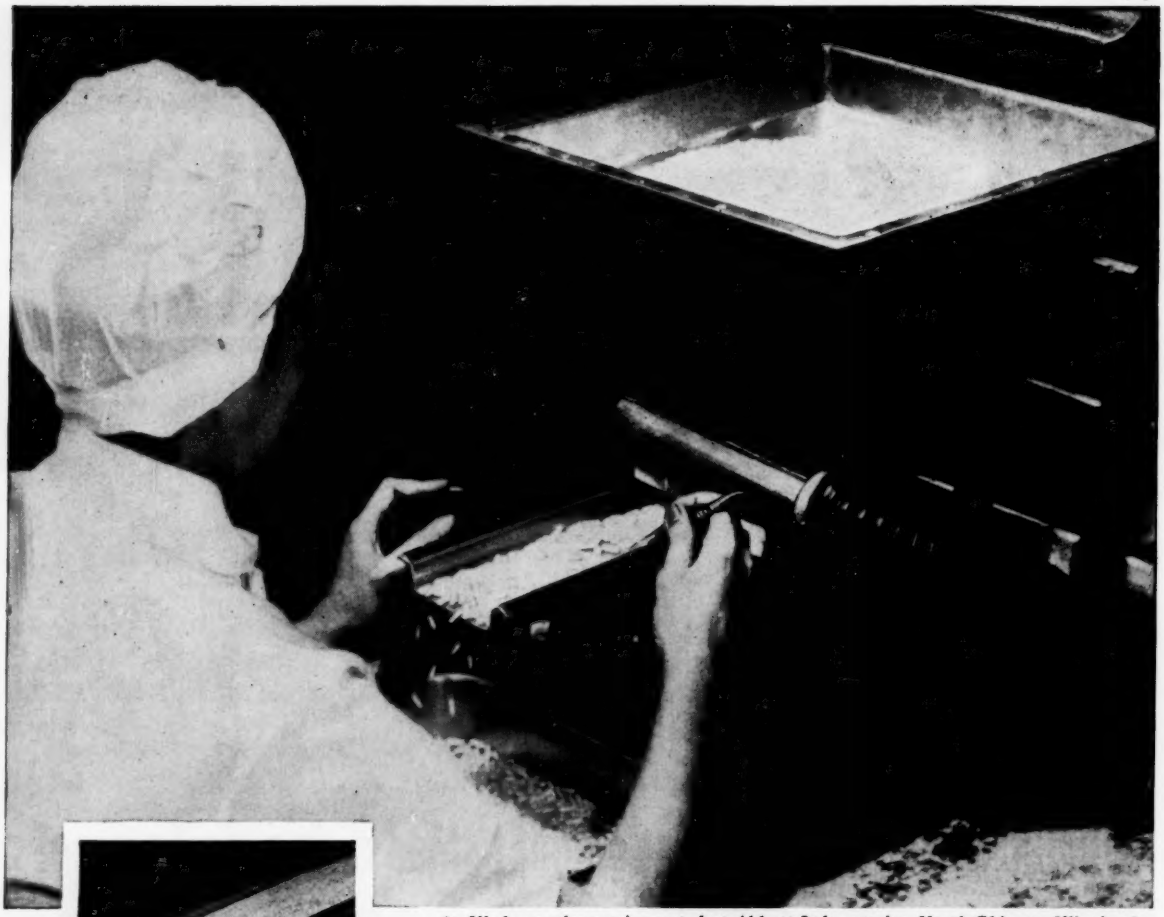
A full line of V5 gauges is available for measuring draft, pressure, differential gas pressure and temperature, and for use as receivers with pneumatic transmitters for indicating flow, liquid level, density, high pressures and other process variables. If you would like to save panel space—without sacrificing instrument readability, performance and flexibility—a talk with your Republic engineer could be time well-invested. A card or a call will bring him. Republic sales offices are located in principal cities throughout the United States and Canada. Detailed information in Bulletin No. 806 . . . your copy is waiting.

A FEW OF THE OPTIONS AVAILABLE:

- Duplex bellows or helix gauges with two pointers operating on the same scale; occupies same space in group as a single-gauge unit.
- Set point indicator available on single bellows and helix units.
- Compound and reversed scales available.
- Reverse acting pointer motion available. (Can be reversed in the field without any change in parts.)
- High and low alarm contacts can be provided with all types of units.

REPUBLIC
FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS
In Canada: Republic Flow Meters Canada, Ltd.—Toronto
Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.



As filled capsules are inspected at Abbott Laboratories, North Chicago, Illinois, the girl suits the speed of the Jeffrey feeder to her requirements with the hand rheostat.

FLOW CONTROL is possible within wide limits, simply by changing feeder's amplitude of vibration.

A way to do what "can't" be done...
JEFFREY Vibrating Feeders

Jobs once considered too costly, too hazardous, or just plain impossible are being done with Jeffrey electric vibrating feeders . . . handling a tremendous variety of materials, densities from 4 to 400 pounds per cubic foot, one micron in size to four-foot cubes, a few ounces to 2,000 tons per hour.

With Jeffrey feeders, the operator has instant and absolute control over the flow of material. This control may be manual or automatic, depending upon equipment that follows, to insure optimum loading. Thus a plant and its workers can produce at top efficiency.

Jeffrey engineers are expert in applying vibrating equipment to all types of processes, and are available to help solve your feeding and conveying problems. Catalog 870 describes these feeders. The Jeffrey Manufacturing Co., 909 North Fourth St., Columbus 16, Ohio.

CONVEYING • PROCESSING • MINING EQUIPMENT...TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

JEFFREY

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

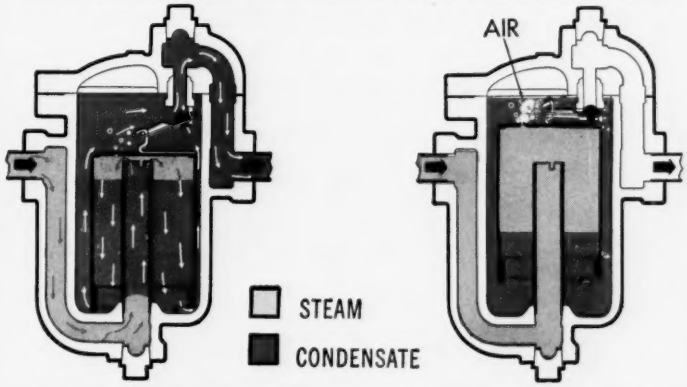
By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
8583 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

Leaders in Your Industry Have Selected "NATIONAL" as the Leader in the Field of PERFORATED APRON-TYPE CONVEYOR DRYERS

Famous names among the manufacturers and processors of chemicals, fibers and allied products are proudly listed in the growing roster of "NATIONAL" customers.

These companies, by their selection of "NATIONAL" Perforated Apron-Type Conveyor Dryers, have demonstrated their belief in the outstanding leadership which "NATIONAL" has earned in the design and construction of this and related types of drying and conditioning equipment.

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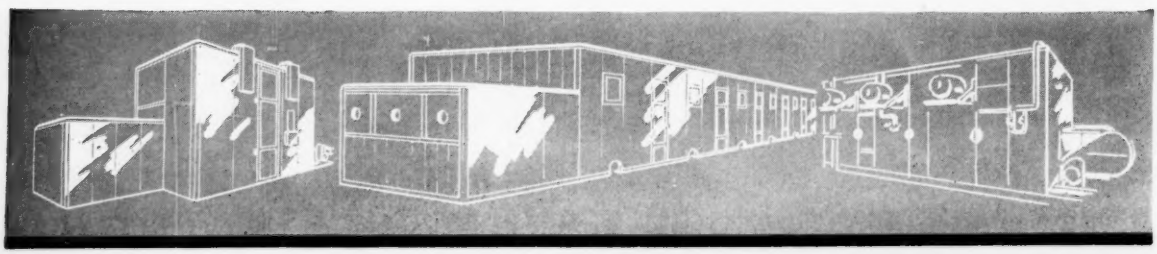
LEHIGH AVE. and HANCOCK ST., PHILADELPHIA 33, PA.

New England Agent: JONES & HUNT, INC., Gloucester, Mass.* *Southern Agent:* F. W. WARRINGTON, Charlotte, N. C.
Cable Address: "NADRYMA"—W. U. Code



Photograph courtesy of Standard Oil Company (N. J.)

When are 16 pipe stills as good as 20?

When a Ljungstrom® Air Preheater gives each one 25% greater capacity

You can get 25% greater production from a pipe still when you install a Ljungstrom® Air Preheater. An Air Preheater can raise combustion air temperature as much as 1,000 F by recovering waste heat from the still exhaust. The increase in combustion air temperature permits an important increase in the output of your still per barrel of fuel consumed.

For example, at one East Coast refinery the installation of a Ljungstrom increased the capacity of a pipe still from 16,000 to 18/20,000 barrels. At this same refinery, the installation of a Ljungstrom, together with modern fuel-burning equipment, gave finer product control which boosted product ratings an average of 2 octane numbers for an added annual income of $58,000.

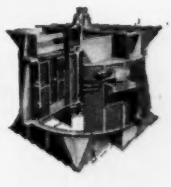
How fast is "WRITE OFF"?

Users report that increased capacity and improved product quality *alone* pay the cost of the Ljungstrom in as little as nine months. You use 20% less of your regular fuel per barrel of output, or you can switch to cheaper fuels that were previously considered useless. Maintenance is less, too, because a Ljungstrom makes the fuel burn more completely, with minimum slag deposits.

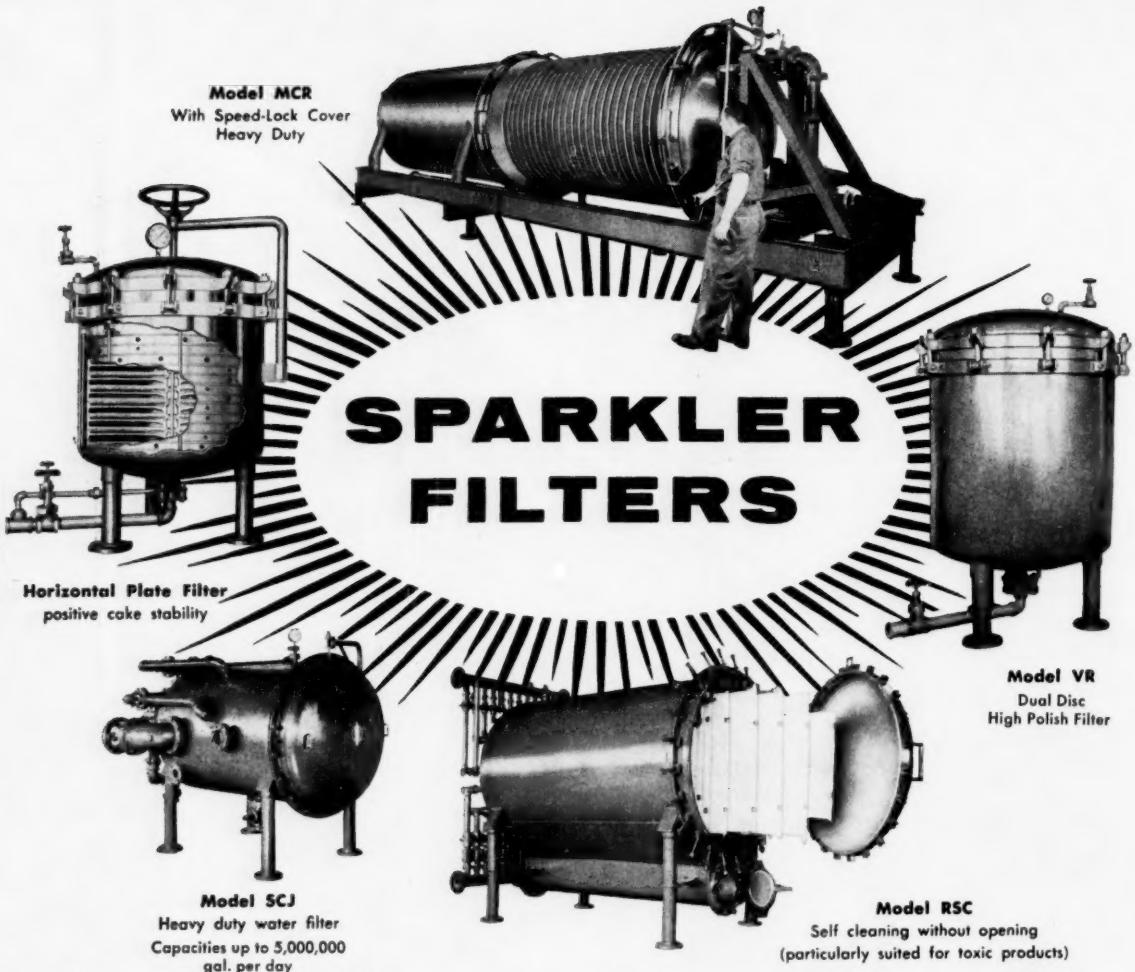
For more complete details on what the Ljungstrom Air Preheater can do for you—for an analysis of the heat recovery benefits attainable in fuel-burning equipment—call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

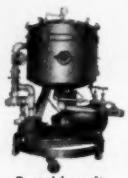
The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.



The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.



Portable filter with slurry tank and feeder.


Portable unit, explosion proof.

Portable unit corrosion proofed, rubber lined with plastic plates.

Portable filter for polishing operations.

Low cost Vacuum Filter.

The most complete line of filtration equipment- engineered to meet the requirements of hundreds of products

By concentrating on filtration engineering and manufacturing exclusively for over 30 years, Sparkler is able to offer a solution to practically all filtration problems without expensive experimentation.

Standard filter models available for:

Chemicals	Electroplating	Varnish
Pharmaceuticals	Petro Chemicals	and Lacquers
Beer,	Petroleum Derivatives	Hydraulic Oil
Whiskey, Wines	Food Products	Steam Condensate

and many other products in addition to large volume water filtration for municipal and plant use. Personal service on all filter installations.

SPARKLER
MANUFACTURING CO.
MUNDELEIN, ILL.

SPARKLER INTERNATIONAL LTD. with manufacturing plants at

Ontario, Canada
1115 Castelfield Ave.
Toronto 10

Australia
Homebush N.S.W.
P.O. Box 13

Amsterdam, Holland
Leliegracht 9
Amsterdam-C

Milano, Italy
c/o Sorapis s.r.l.
Via Padova 844

Order PITTSBURGH MOLTEN PHTHALIC!

IF YOUR plant has facilities for receiving phthalic anhydride in molten form, you can make a substantial reduction in your handling and processing costs. Delivered by insulated tank truck or tank car, *Pittsburgh* molten phthalic can save you money these four ways:

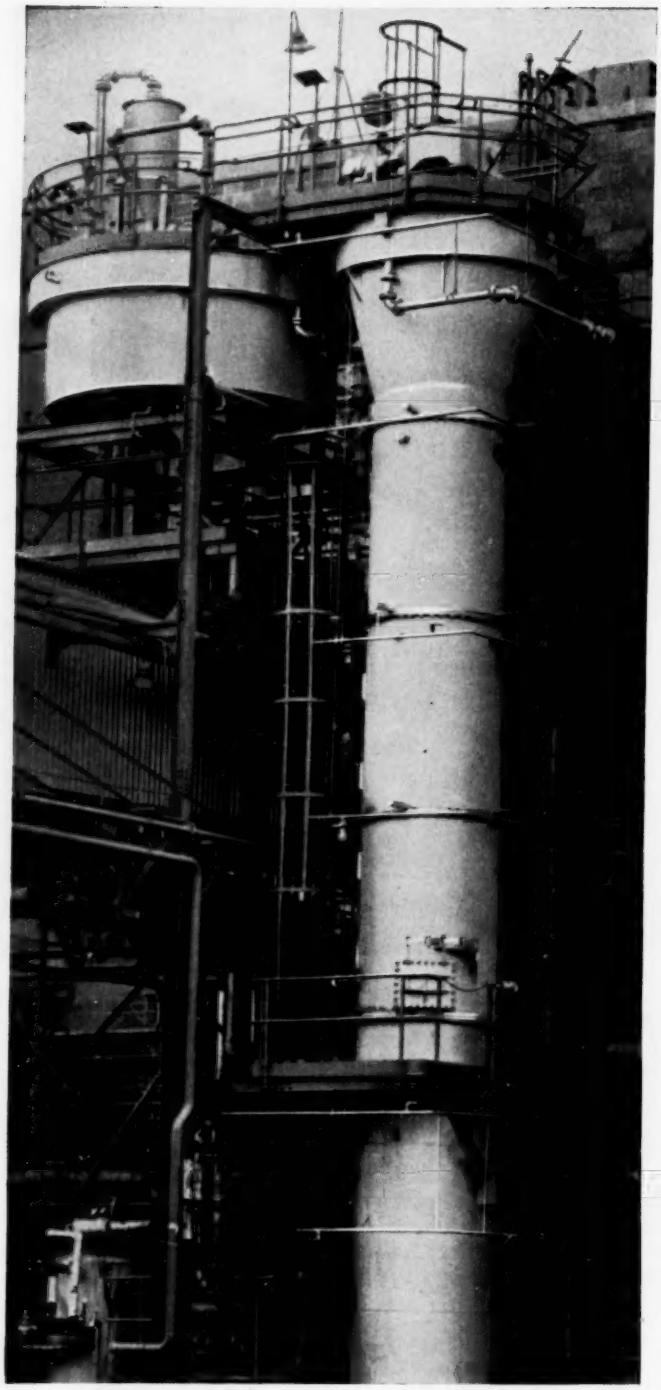
1. Lower cost per pound.
2. Lower handling costs.
3. Less warehousing and inventory space.
4. Reduced processing time.

Quality-controlled at every step of production, *Pittsburgh* Phthalic Anhydride maintains good molten color stability over long periods, and requires no special alloy steels for handling. It is essentially free of maleic anhydride and benzoic acid, thus assuring uniform reaction rates and reducing product variations.

Let us know about *your* P.A. problems today. *A call or wire will place an experienced Pittsburgh Industrial Chemicals man at your service!*

WBW 7046

COAL CHEMICALS • PLASTICIZERS • PROTECTIVE COATINGS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON



Special Manhattan Rubber Lining to resist acidified solvent and abrasive cake is installed in this extraction tower for removal of anti-biotic from mycelia cake.

PERMANENT CORROSION, CONTAMINATION PROTECTION WITH MANHATTAN RUBBER LININGS

Manhattan Acid-Proof Rubber Linings are made from thick, multiple calendered sheets of natural or synthetic rubber for utmost protection and durability. These linings expand and contract with the metal under temperature changes . . . won't harden or crack. Resistance to most acids and alkalis is as foolproof as 65 years experience and advanced technology can provide.

Every Manhattan Rubber Lining is bonded to metal so securely that they can't be separated . . . Every Manhattan Lined tank is tested under high voltage to assure flawless protection before being shipped to your plant. If the equipment *can't* be shipped to Manhattan, skilled crews will line the equipment in the field.

For permanent, positive protection for your processes *and* equipment, contact the R/M representative at the Manhattan Rubber Lining plant nearest you.

RUBBER LINING PLANTS AT
PASSAIC, N. J. and NORTH CHARLESTON, S. C.

RM 806

BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

RM

variable speeds direct from standard AC power lines... with

U.S. VARIDRIVE MOTORS

Smooth, stepless speed changes to the split RPM—with the simple, completely self-contained U.S. VARIDRIVE MOTOR! Just plug into any standard AC power line.

Why bother with DC Converter, DC Generators, complicated electronic tubes and circuits that require special technicians? Why risk costly production shutdowns?

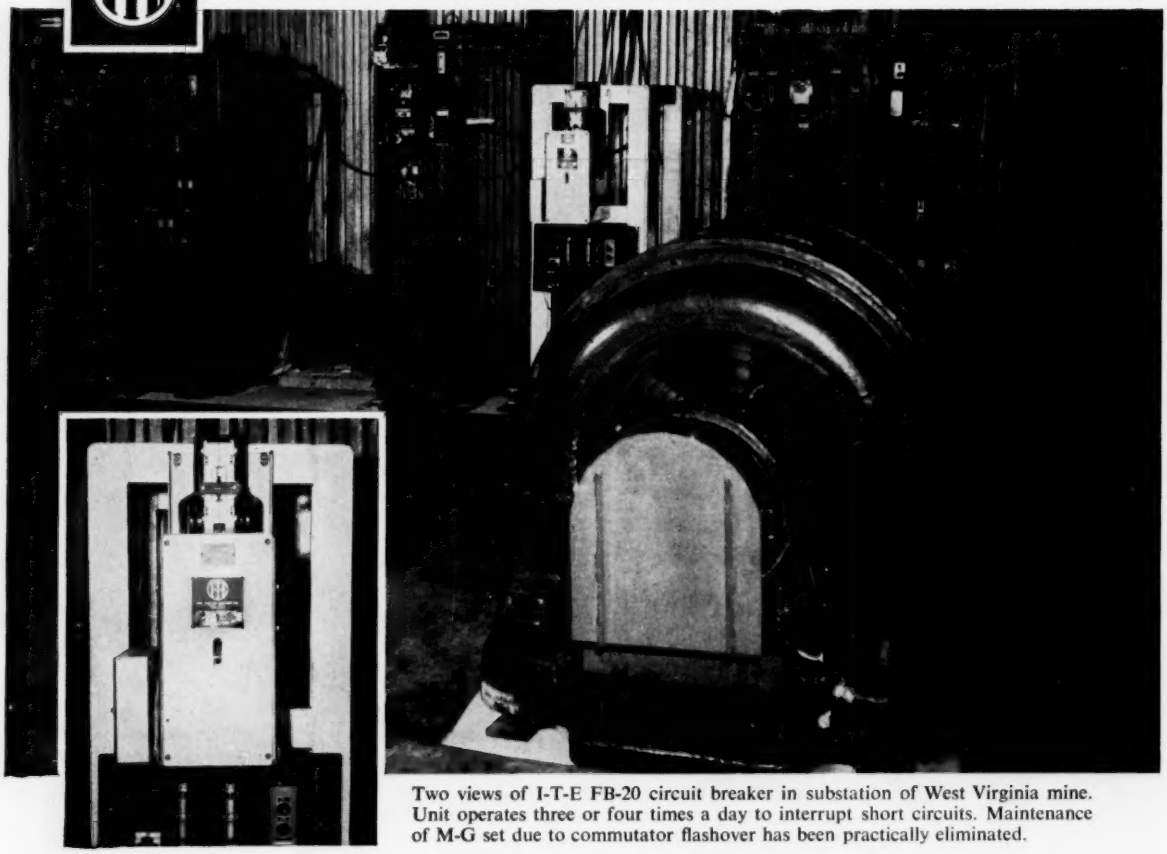
You avoid complications when you choose U.S. VARIDRIVE—dependable, simple, easy for ordinary personnel to maintain. Available in RATINGS ¼ TO 60 H.P. Specify: "U.S. VARIDRIVE MOTOR."

U.S. ELECTRICAL MOTORS INC.

P. O. BOX 2058, LOS ANGELES 54, CALIFORNIA
OR MILFORD, CONNECTICUT

FREE COLOR-ILLUSTRATED BROCHURE
... Send for U.S. Varidrive Bulletin 1797

DIRECT CURRENT FB CIRCUIT BREAKERS



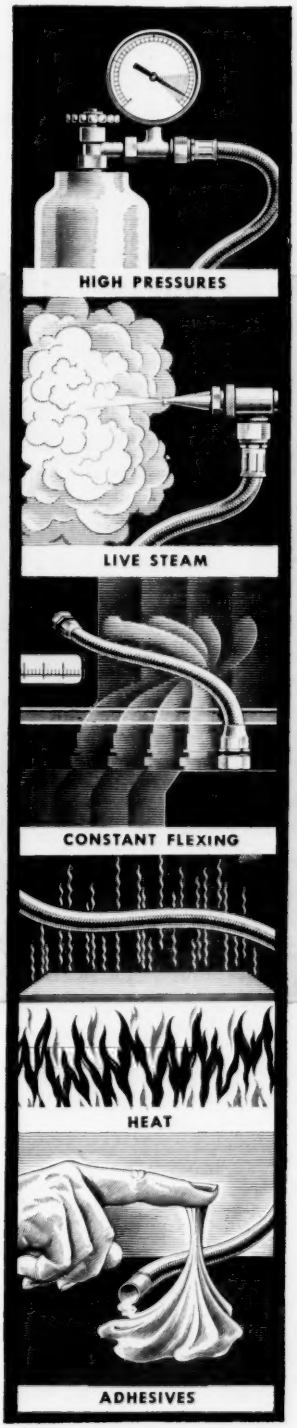
Two views of I-T-E FB-20 circuit breaker in substation of West Virginia mine. Unit operates three or four times a day to interrupt short circuits. Maintenance of M-G set due to commutator flashover has been practically eliminated.

Reduce maintenance on 600 volt M-G sets by preventing commutator flashover damage

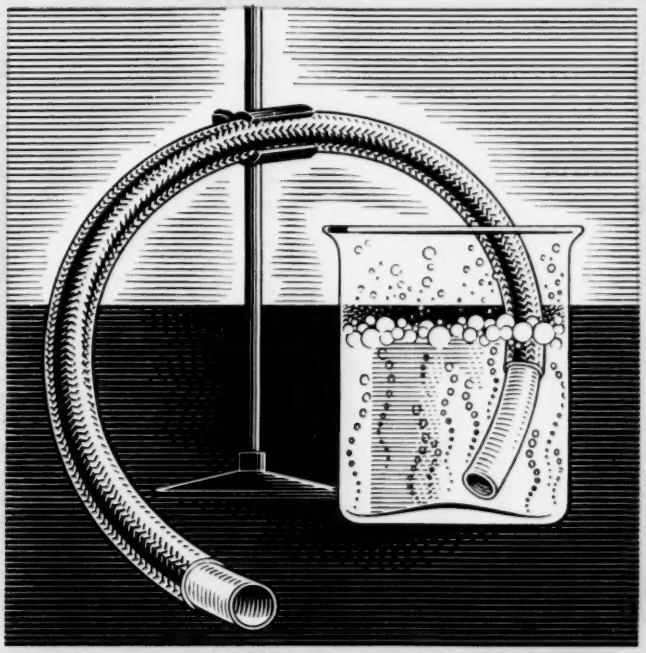
A large mine in West Virginia uses a 2000 amp I-T-E current-limiting type FB-20 circuit breaker to protect a 600 v motor-generator set in its substation. This substation supplies direct current to haulage equipment and mining machinery underground. Short circuits occur frequently due to roof falls, cable cuts and similar exigencies—in fact the FB-20 circuit breaker interrupts as many as four times a day; and the M-G set has never suffered any damage. In contrast, the protective device used before permitted some commutator flashover, and costly maintenance work resulted.

I-T-E FB Line circuit breakers are designed to give high-speed fault protection to d-c generators, d-c traction or driving motors. They are also applied as feeder breakers for overcurrent tripping on selective systems and as anode breakers on mercury arc rectifiers. I-T-E quality means years' longer trouble-free service in your plant. Why not take advantage of it. For complete information, contact your nearest I-T-E sales office. Or write Switchgear Division, I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa. In Canada: Eastern Power Devices Ltd., Port Credit, Ont.

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA



Is your problem corrosive chemicals?



Save maintenance and replacement costs with hose of TEFLON® TFE-fluorocarbon resins

If your hose lines are cracking up under the strain of tough processing conditions, there's a solution in hose made of TEFLON* TFE-fluorocarbon resin. This hose is totally inert to virtually every chemical in the book. It is rated for continuous use up to 500°F. and can be made to withstand 3000 psi. It will handle superheated steam without failure, yet it is useful even in liquid oxygen service. Hose of TFE resin is extremely tough and long-lasting.

Hose with this sort of durability in chemical and petrochemical applications is bound to save you time, trouble and money. Why not ask your dealer about hose of TFE resins?—or write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 75, Du Pont Building, Wilmington 98, Delaware.

In Canada: Du Pont Company of Canada (1956) Limited, P.O. Box 660, Montreal.

*TEFLON *is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.*

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Where a misstep costs $500... Blaw-Knox Electroforged® Steel Grating provides safer non-slip footing

Stair falls cost industry over $60,000,000 a year.

An average accident amounts to a loss of $500 in claims.*

A good way to guard against these profit-eating accidents is to construct your stair treads, walkways and floors with Blaw-Knox Electroforged Steel Grating. Non-slip twisted crossbars and a wide variety of bearing bars are available to meet every kind of working condition—safely solving the most hazardous skid situations.

Rigid, one-piece construction makes installation easy. Once on the job, Blaw-Knox grating practically takes care of itself. There is nothing to wear, nothing to patch, no dirt collecting corners to clean. It goes anywhere, fitting neatly around pipes, beams and machinery, admitting plenty of light and air to the area.

Made to your specifications, Blaw-Knox grating provides new highs in safety, easy up-keep and flexible application. For new ideas about grating—including space saving platforms and shelving, write for Bulletin 2486.

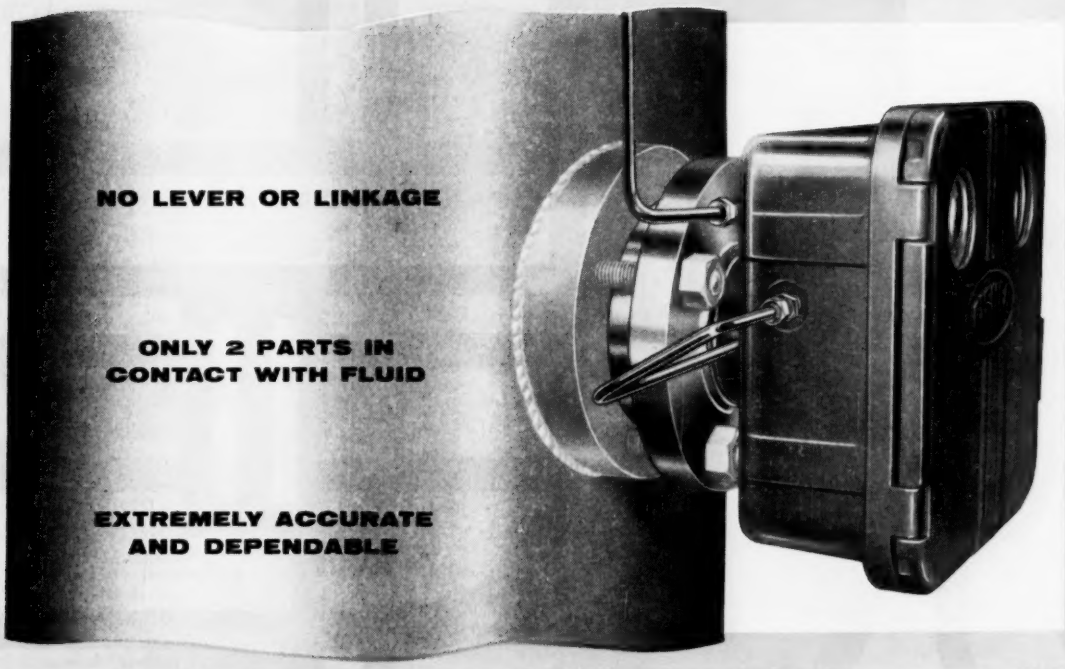
*Based on a study analyzing 803 compensable work injury claims closed in Illinois involving stairs and steps.

BLAW-KNOX

BLAW-KNOX COMPANY

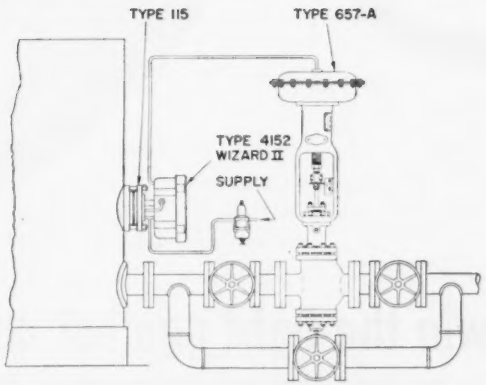
Equipment Division
Dept. C, Pittsburgh 38, Pennsylvania

For that hard-to-handle liquid... consider the "115" Transmitter



Ideal as a liquid level transmitter for slurries, paper stock, and viscous or corrosive fluids

Flange mounts direct to side of tank. Only the diaphragm and the diaphragm ring come in contact with the fluid. Diaphragm is Teflon impregnated glass cloth ... ring can be stainless steel or some other corrosion resistant material of your choice. Pneumatic output of the "115" is a 1 to 1 measure of the liquid head in the vessel. Frequently supplied with the popular Fisher Wizard II as the controller which makes a complete and compact assembly for liquid level control application. Also used as a transmitter for remote, level indicating, recording or controlling. Primarily for open tank service, the "115" is used in pipe lines and vessels with pressures up to 75 psi. For complete information on the Fisher "115" write for Bulletin F-115.



Fisher "115" with the Wizard II as the controller on a liquid level control installation.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD ... CHANCES ARE IT'S CONTROLLED BY

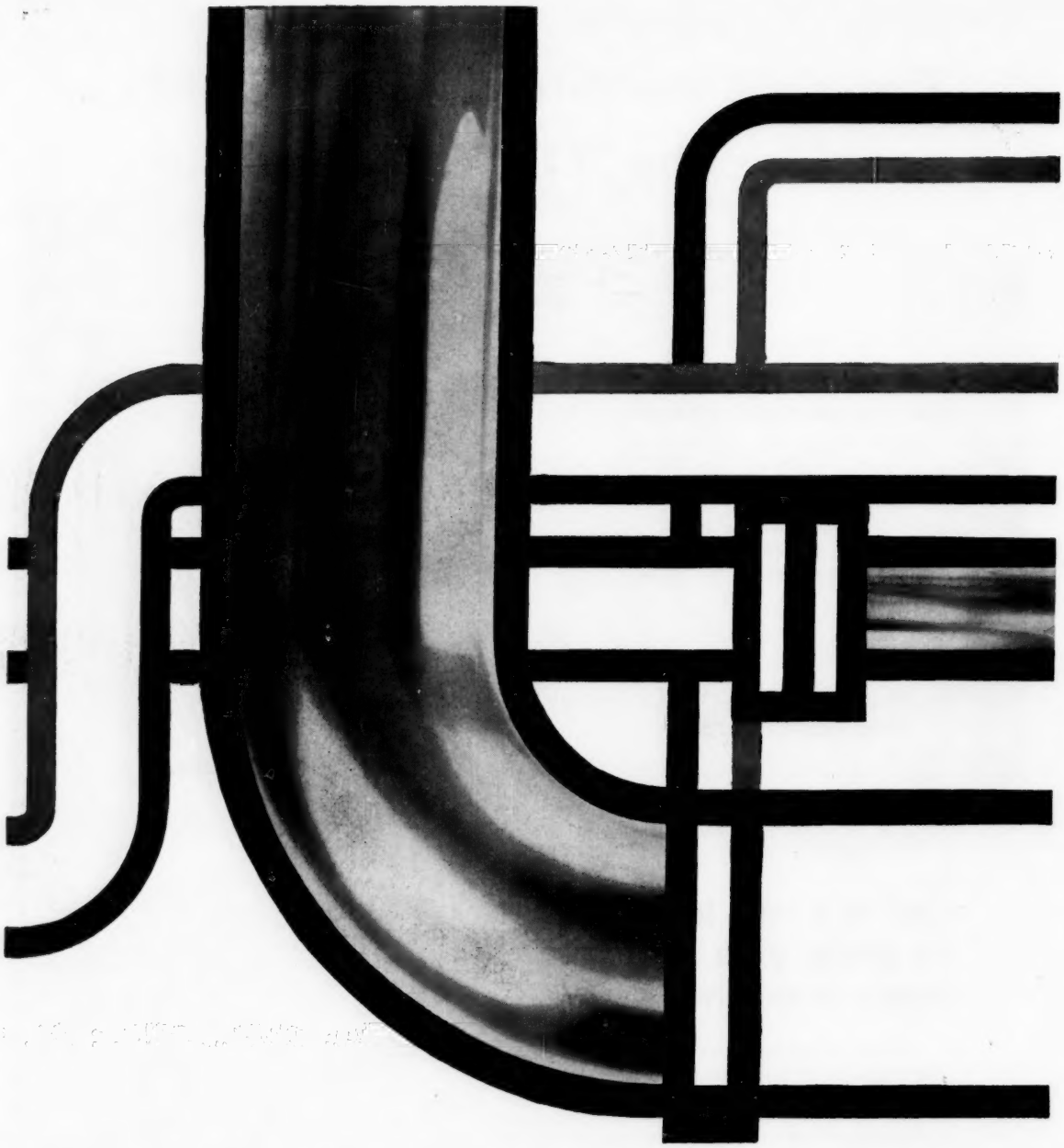
FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

FISHER® Control

SINCE 1880



win the fight against corrosion—with Alcoa Aluminum

For over 30 years, Alcoa development engineers have successfully employed the outstanding corrosion resistance of aluminum to solve corrosion problems in the process industries. Their unparalleled knowledge of aluminum's behavior in corrosive situations can furnish proved solutions to your most serious corrosion problems. Let Alcoa show you how to *win the fight against corrosion—with Alcoa® Aluminum.* You'll get these extra benefits, too: Light weight • Good workability Low cost • High thermal and electrical conductivity • Great strength in alloys • Non-sparking characteristics • Non-toxicity • Good reflectivity • Clean, attractive appearance.

For immediate help, outline your corrosion problems in a letter to ALUMINUM COMPANY OF AMERICA, 903-E Alcoa Building, Pittsburgh 19, Pennsylvania.

"ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings

ALCOA ALUMINUM

Specify Alcoa Aluminum for
corrosion-free Process Equipment
Pipe & Tube
Tanks, Containers, Trucks & Cars
Plant Structures

Chemical Engineering

Developments

MAY 19, 1958

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Packaged sulfur recovery unit pays off 64

When acid gas goes up the stack, potential profits puff out along with it. A real economical stopper—this unit's conversion efficiencies are high; operating costs, low.

This firm saved $100,000 on cost of moving materials 68

The first year that Union Carbide Chemicals set up its new system for moving construction materials, it cut expensive manual handling by 45% and streamlined handling cycle.

New Resin boasts strength and whiteness 74

Dow's high capacity styrene-based cation exchange resin is white in color and is said to give maximum resistance to oxidation, reduction, mechanical wear and breakage.

This scrubber whisks away naphthalene snow 78

At its new chemical recovery unit, U. S. Steel will soon bring on stream a new perfected design of a venturi scrubber—to halt naphthalene clogging of mains and towers.

Though processors have cut capital outlay 86

Most chemical process firms are sinking more and more into research and development. With spending already at the $1 billion level, they expect to top $1.2 billion in '61.

New **CROUSE-HINDS**
EXPLOSION-PROOF
MERCURY VAPOR
LIGHTING FIXTURES

For dependable security at low operating cost in hazardous locations . . .

- *where long burning hours without interruption are involved, month in, month out*
- *where labor cost or trouble of relamping is an important factor*
- *where maximum lighting output calls for maximum economy in power consumption*

The longer life of mercury vapor lamps is well established: 7000 hours, *vs.* 1000 hours for incandescents. Light output is 2.5 times greater; 55 lumens/watt, *vs.* 22 lumens/watt for incandescents.

The new EV's place these economies within easy reach. As with all Crouse-Hinds explosion-proof devices, EV's are heavily constructed to withstand the pressure of internal explosions without rupturing. Gas-tightness is *not* a requirement for their safe performance. Flame-tight joints prevent the escape of flames to flammable atmospheres.

- *For full information, call your Crouse-Hinds distributor, or write for catalog sheet.*

TYPE EVA Explosion-Proof Lighting Fixture

Available with or without guard, or reflector (dome, deep bowl, shallow bowl, angle, or high bay)

250 Watt— National Electrical Code: Class I, Groups C & D

400 Watt— Class I, Group D

CROUSE-HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

● CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) ● FLOODLIGHTING
● TRAFFIC CONTROL SYSTEMS ● AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington **Resident Representatives:** Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport

DEVELOPMENTS . . .

MAY 19, 1958

Chementator

C. H. CHILTON

Dow will build a plant in Cleveland to make its new oriented polystyrene film. Product is designed for packaging uses, poses a threat to cellophane.

Heavy water may be slated for greater use as moderator and coolant in nuclear power reactors. Kaiser Engineers is designing a 200-thermal-mw. boiling-heavy-water reactor which would supply process steam and power to an unidentified chemical producer.

Reinforced plastic construction of evaporators is Maxim Silencer's approach to lower-cost equipment for desalination of sea water. Triple-effect test unit has racked up 1,000 hr. of continuous operation.

Automatic control by chromatography

Through use of a specially designed "peak reader," Phillips Petroleum Co. has successfully applied gas chromatography to automatic closed-loop control of a fractionator.

Phillips conducted a one-week test of its new control system recently on a 13-ft.-dia., 50-tray debutanizer at its Sweeny, Tex., refinery. Although the test instrument subsequently was transferred to other experimental duties, Phillips is now installing another on a permanent basis.

Gas chromatography furnishes a periodic rather than a continuous analysis (*Chem. Eng.*, June 1956, pp. 116-120), complicating its application to continuous feedback control. Phillips' new peak reader simply reads the peak height of the key component and puts out a continuous equivalent signal which is corrected automatically every 5 min. on each cycle of the analyzer. In the Sweeny debutanizer operation, the analyzer measures isopentane on the ninth tray, controlling steam flow to the reboiler through a temperature controller on the fourteenth tray.

Phillips plans to exploit its new control technique further in other applications. Development of high-speed analyzers—with cycles of 30 sec. or less—portends a bright future for closed-loop control by chromatography.

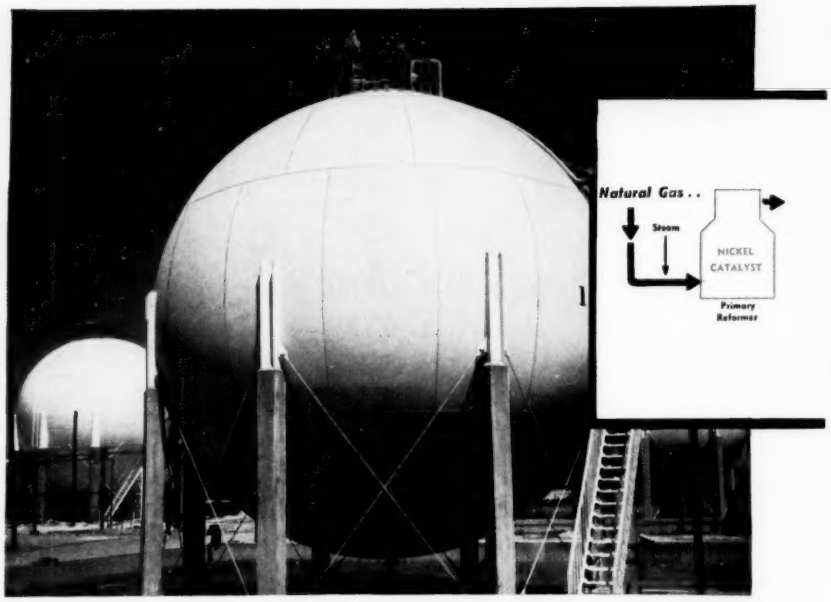
Gel propellant affords easy control

Solid or liquid propellants for rockets and missiles? As pointed out in our feature report in this issue (pp. 145-160), each type has its pros and cons.

A new type of propellant now under development neatly combines significant advantages of both liquid and solid systems. It is a heterogeneous, gel-type monopropellant originated by Atlantic Research Corp., Alexandria, Va., and known as Arcogel.

(Continued on page 60)

Life on the Chemical Newsfront



ECONOMY IN PRODUCTION of hydrogen and ammonia results from the use of Cyanamid's AERO® *catalyst NR-1* for gas reforming, *HI-3* and *3A* for water-gas shift reaction and *FM-2* for ammonia synthesis. These catalysts are products of more than thirty years' experience in catalyst development and engineering. They provide high catalyst activity, stabilized to remain high for long periods; physical strength to resist breakdown; optimum size and shape to ensure low pressure drop through catalyst beds; and low volumetric cost. Complete brochure available on request.

(Industrial Chemicals Division)

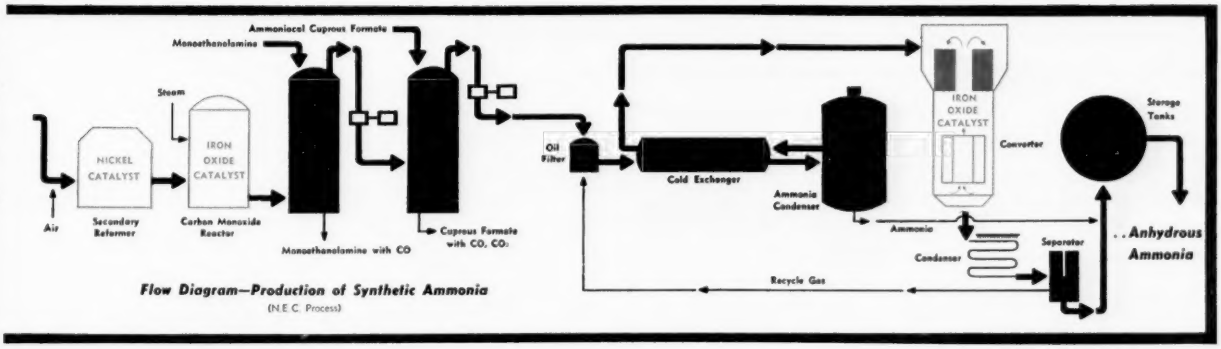
GIVING A GENTLER "HAND" TO FABRICS is the role of softeners in textile processing. By lubricating fibers and softening resin additives, these textile chemicals give fabrics a better drape and improved appearance—also facilitate cutting and sewing in garment manufacture. Cyanamid's complete line of CYANATEX® and AEROTEX® *textile softeners* ranges from sulfonated natural fats and oils to completely synthesized chemicals designed to provide specific fiber-modifying properties.

®Trademark

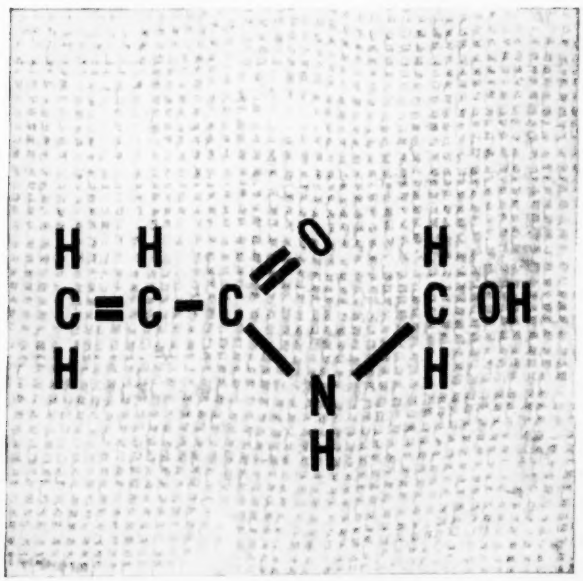
(Organic Chemicals Division)

MANY NEW FLEXIBLE PACKAGING MATERIALS, as in this tobacco pouch, are being coated with polyvinyl acetate for improved moisture and grease resistance and clarity over printed matter. Especially effective as a PVA emulsifier is Cyanamid's new AEROSOL® TR *surface active agent*. AEROSOL TR produces a uniformly low particle size—2 to 2½ microns—through an unusually wide range of concentration from 0.05% to 1.0%. Emulsion and cast film benefit by increased stability and good dry film resistance to moisture, grease and water-spotting.

(Industrial Chemicals Division)



Flow Diagram—Production of Synthetic Ammonia
(N.E.C. Process)



"WARP AND WEFT" FOR WEAVING POLYMERS are provided by the new bifunctional monomer *N-methylolacrylamide*. Since the monomer contains both a conjugated vinyl group and a reactive hydroxymethyl group, linear polymers can be formed, followed by cross-linking if desired through the remaining unreacted functional group. Addition reactions of the vinyl group, followed by condensation polymerization, further extend the structural possibilities. N-methylolacrylamide thus offers the possibility of formation of a wide variety of products for adhesives, cements and thermosetting plastics. We will be pleased to forward additional information on request. **(Market Development Department)**

NEW STABILITY IN SUNLIGHT for plastic boat hulls now can be secured by adding as little as 0.25% of UV 9* *ultraviolet absorber* to the polyester resin before laminating with glass fiber. Highly effective as a light stabilizer, UV 9 protects polyester resin laminates from discoloration and degradation through its remarkable ultraviolet-absorbing properties. The useful life of stabilized polyesters, methacrylates and styrene polymers is multiplied many times. Clarity of the resins, formulation schedules, and properties of the cured resin are unaffected. **(Organic Chemicals Div.)**

CYANAMID

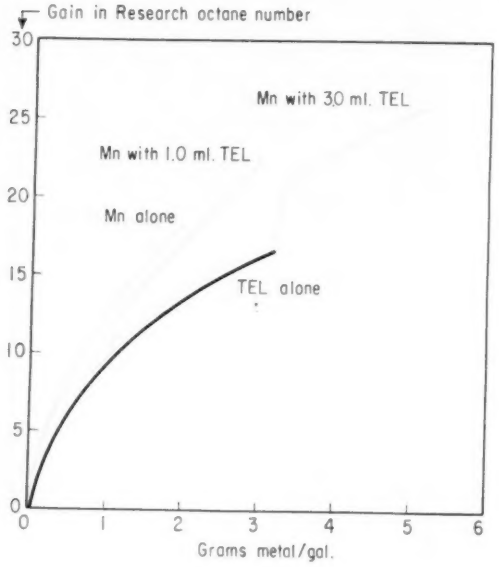
AMERICAN CYANAMID COMPANY
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

For further information on these and other chemicals, call, write or wire American Cyanamid Company

As a monopropellant, Arcogel avoids the problems involved in proportioning and mixing liquid fuel and oxidizer at point of burning. And it affords the advantages of controllable feed rate and shut-off—elements of flexibility lacking in solid monopropellants.

Atlantic Research has granted Thompson Products, Cleveland, exclusive rights to purchase, use and sell Arcogel. Atlantic will be the manufacturer and is continuing to work on specific fuel formulations as well as on engineering development of burner systems. Thompson's engineers are exploring systems using the combustion gases from the burner. This work apparently includes gas turbines and torpedo propulsion in addition to missile applications.

Mn chemical boosts octane numbers



Ethyl Corp.'s disclosure last month of performance data and probable cost of its new manganese antiknock agent set slide rules and desk calculators humming as petroleum industry technologists checked cost of this new octane improver vs. alternative routes to higher octanes (e.g., isomerization, alkylation, severe catalytic reforming).

The company identified the new compound chemically as methyl cyclopentadienyl manganese carbonyl, a light amber liquid called, for simplicity, AK-33X.

Though the compound is not yet commercially available, Ethyl has suggested that the petroleum industry assume a price of 0.85¢/gm. of Mn in its economic evaluations. At this assumed price, AK-33X would cost four times as much as tetraethyl lead on the basis of metal weight.

On the other hand, AK-33X is a more effective octane raiser per unit of metal weight than TEL, as shown in the above graph. Ethyl's studies—covering 30,000 hours of laboratory and engine testing plus several million miles of vehicle testing—indicate that the Mn agent may be used to best advantage in combination with TEL.

Over the years since discovery of TEL, Ethyl researchers have constantly sought new antiknock compounds. Up to now, none has proved commercially feasible. Recent advances in the chemistry of organometallic compounds, however, are now bearing fruit for Ethyl.

New ethylene oxide process on stream

Use of oxygen instead of air for direct oxidation of ethylene to ethylene oxide is making its commercial debut in a big way. Three new plants—first to employ the Shell Development process—will start up in rapid-fire order between now and Labor Day.

Wyandotte Chemical, Geismar, La., gets under way this month. Calcasieu Chemical, Lake Charles, La., expects to be running next month. And Shell Chemical has a plant ready to go at Partington, England, awaiting completion this summer of facilities for ethylene supply. All three plants were built by Lummus Co. Each will produce about 60 million lb./yr.

In view of the fact that other direct oxidation processes use air, how do Shell and its licensees justify the expense of installing and operating oxygen plants?

A Shell spokesman explains that eliminating nitrogen from the process results in an over-all reduction in fixed investment and operating costs. Process equipment is smaller, power costs are lower with less gas to handle through the system. Absence of nitrogen also permits recycle of unconverted ethylene to get optimum economic yield. The new process, incidentally, employs a silver catalyst which differs from others in choice of carrier and method of deposition.

Shell's process competes directly with air-oxidation processes, such as that offered by Scientific Design Co. In fact, Shell's early process development work used air. Economic

(Continued on page 62)

News from
National Carbon Company
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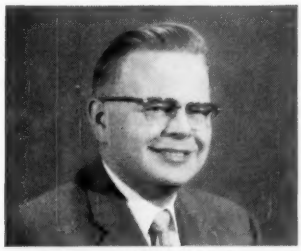
National Carbon representatives expand your engineering force



L. E. BRUGMANN,
SALES ENGINEER

Mr. Brugmann was graduated from Purdue University with a B.S. Degree in Chemical Engineering. For three years he worked in the midwest as a process engineer with a large chemical company. His work covered development of new chemical processes and the improvement of existing processes, both from the technical and economical aspects of the process. It was necessary for Brugmann to know the required equipment thoroughly, to work on the design of new equipment and to draft an economic evaluation of any changes.

Mr. Brugmann has been with National Carbon Company since 1954. His first two years were spent in the Cleveland Office working up Engineering Proposals on incoming inquiries from chemical and allied industries. He has been a field engineer covering the west coast since 1956. Call your National Carbon Sales Engineer today.

"KARBATE" PUMPS HANDLE A WIDE RANGE OF CORROSIVE SERVICES EFFICIENTLY AND ECONOMICALLY

This carload of "Karbate" pumps was shipped to a major rayon producer.

During the past twenty years, "Karbate" impervious graphite pumps have gained an envious performance record corrosion wise. A recent survey on service applications indicates these pumps handle a wide variety of corrosives over a wide temperature range. Some of these solutions are: hydrochloric acid, all concentrations; phosphoric acid – up to 75%; sulphuric acid from 1 to 93%; chlorinated hydrocarbons such as benzene hexachloride, monochloracetic acid, DDT; mixed acids such as nitric-hydrofluoric, sulphuric-hydrofluoric, hydrofluoric-chromic oxide, chromic-nitric hydrofluoric, phosphoric-hydrochloric nitric; chlorinated sodium and potassium chloride brines, ferric chloride; caustic; chlorine saturated water.

The excellent corrosion resistance of "Karbate" pumps permits a given plant to utilize one type pump for all corrosive services. Such a pump standardization means a saving in pump parts inventory, and also means lower maintenance costs due to greater proficiency in handling one type pump.

"KARBATE" PUMPS FEATURE LOW MAINTENANCE COSTS

A rayon manufacturer reports using "Karbate" impervious graphite pumps to handle rayon spin bath solutions. Maintenance costs on each pump were $25.00 the first year and $25.00 the second year – costs on an alloy pump were $25.00 the first year and *$500.00 the second year.*

A major chlorine producer is using "Karbate" impervious graphite pumps to handle chlorinated cell brines. Eighteen pumps are in service. Maintenance costs on the "Karbate" pumps are approximated at $100.00 per pump per year as compared to costs on another non-metallic type pump of *$500.00 per pump per year.*

• • •

"KARBATE" PUMP TABLE OF SIZES AND CAPACITIES

Pump size Suction		Discharge	Motor-Mounted Type F	Frame-Mounted Type C
2	x	1½	29-FAL	1½-CB
3	x	2	19-FAL	2-CA 2-CB
4	x	3	—	3-CA 3-CB
6	x	4	—	4-CA

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UNION CARBIDE

analysis convinced Shell engineers, however, that oxygen was preferable in large plants; break-point lies between 10 and 20 million lb./yr., depending on specific local economic conditions.

As evidence of the soundness of this reasoning, Shell Development points out that air oxidation was considered—and vetoed—by all three of its licensees. The real proof, however, will come in the next three months.

Fumaric acid from sulfite liquor?

Work now under way at the Taft Sanitary Engineering Center, Cincinnati, may lead to commercial production of fumaric acid from waste sulfite pulping liquor, as well as aid in pollution abatement.

Researcher A. H. Romano has found that the sugar content of sulfite liquor (usually 16-20% of the total solids) can be fermented to fumaric acid with a weight yield of about 40% on the sugar. Removal of sugars offers two additional major benefits to sulfite pulpers harried by pollution problems:

- Inasmuch as sugars account for 60-65% of the BOD content of the liquor, the pollution load would be lightened to that extent.
- Production of potential lignin byproducts would be aided by prior removal of sugars.

Waste liquor from only 200 tons/day of pulp production could supply present U. S. demand for fumaric acid, now made chemically from benzene or by fermentation of molasses. Lower prices than the current 27-28¢/lb. would likely open up bigger markets, such as those now supplied by maleic anhydride, the waterless isomer of fumaric acid. Lower costs could be achieved, says Romano, only by finding ways to speed up severalfold the 3-to-4-day laboratory fermentation cycle.

New vinyl finish cures by baking

Conversion of a thermoplastic polymer to a thermosetting one characterizes a new baked-on finish for metals developed by Canadian Industries Ltd. This principle, more familiar in reinforced plastics, is still relatively rare in the coatings field.

CIL's Dynakote consists, before application, of short-chain-length molecules in solution. Applied by conventional means and baked on at about 280 F., it cures by two mechanisms: a vinyl-type polymerization to larger molecules plus an expoxy-type cross-linking.

The carbon-carbon double bond in the monomer can be supplied by a range of vinyls and acrylics, among others. But for practical workability, selection of the right monomers is critical. Identity of CIL's is under wraps.

While now costing some 10% more than conventional alkyd baking finishes, Dynakote offers improved appearance, gloss and chemical resistance. In addition, it can be applied directly to bare metal, without a primer. Canadian Frigidaire is already using Dynakote on its new line.

CIL is now negotiating for license to sell Dynakote in the U. S. However, it will meet with tough domestic competition. Pittsburgh Plate Glass already has on the market a new thermosetting acrylic baking finish called Duracron. And Du Pont is getting ready to introduce its entry within the next few months.

Yankee engineer go home

While Chemical Institute of Canada was playing the perfect host to AIChE at Montreal last month amidst pledges of mutual aid and cooperation, other Canadian groups were bitterly complaining about the "growing domination by U. S. engineers in Canada's economy."

A spokesman for Canada's Association of Professional Engineers accused U. S. companies with Canadian subsidiaries of exporting surplus engineers to Canada and firing Canadians to make room for them. "If we can show that entrance into Canada of a U. S. engineer is filling a position that a Canadian is competent to do," he warns, "we can stop him." Present legislation, rarely enforced, permits border authorities to refuse admittance to U. S. engineers.

An official of another group, the Association of Consulting Engineers, claims that U. S. engineers "are coming in and taking our jobs." Of the nearly 17,000 engineers registered in Ontario, for example, more than 10% are U. S. citizens. U. S. engineers are said to be "dominant" in petroleum, petrochemicals, and mining and metallurgy.

Meanwhile, back in the U. S., engineer-immigrants are coming in at a rate equivalent roughly to 10% of new B. S. engineering graduates; one-fourth of these immigrants come from Canada.

For more on DEVELOPMENTS.....64

More proof!

ISOPHTHALIC RESINS are the answer to superior PLASTIC and SURFACE COATING products for industry

Plastic duct made with Isophthalic resins combines light weight with high strength and superior resistance to corrosion. This fiber glass duct, 25 to 36" in diameter, part of a plant's fume control system, will last for years despite constant exposure to corrosive acid fumes. Superior wetting characteristics of Isophthalic resins reduced fabricating costs, provided a stronger laminate.

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If you would like to know how Isophthalic resins can benefit your products — ask your resin supplier or, contact Oronite directly for complete information on applications, formulations and instructions on their preparation, product samples. Evaluate Isophthalic resins in your own laboratory.

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4829

Unloader transfers incoming material directly onto truck pallet.

From receiving dock on through storage areas and out to the plant site, construction materials now move as unit loads carried by fork trucks and straddle carriers.

Trucks drop pallets at "shelter" to await transfer by straddle truck to open storage.

Unit Loads Trim Cost of Moving Construction

AT INSTITUTE, W. Va., Union Carbide Chemicals Co. now moves construction materials by a new system that turned in a $100,000 saving during the first year of operation.

Savings fall mainly into two areas. First, expensive manual handling has been cut 45%. Second, there are fewer handling steps.

For the most part, materials now go through a simple three-stage cycle of receiving-storing-delivery. System practically eliminates manual handling into and out of intermediate storage areas.

▶ **Took Builder's Cue** — When Carbide's Department of Design and Construction scutinized construction costs, it concluded that considerable savings could be won by revamping the movement of incoming materials to the plant site. By adapting a technique used successfully by building-supply dealers, Carbide came up with a new system for unloading, storing and delivering materials used in plant construction.

▶ **Pallets for Everything**—Carbide's success in reducing handling costs lies in its ability to unitize all materials on pallets, despite wide variance in size and shape, and then to find carriers able to handle such loads.

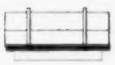
Every item is unloaded directly from the common carrier onto a pallet or bolster (pallet designed for unusual load such as pipe) where it remains during various steps in delivery to point of use.

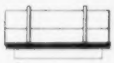
In addition to palletizing conventional items such as cartons of nuts and bolts, and kegs of nails, Carbide also unitizes cement, acid brick, gypsum block, resin, lumber, valves, flanges and carbon brick, to name a few materials.

But the biggest saving of all has stemmed from Carbide's ability to handle unit loads of structural steel and pipe. Previously, they were moved by crane and a 3-man crew from receiving, to storage, to point of use. Now, cranes are used only to unload them from railroad cars and to erect them at the job site. In between, steel and pipe travel as unit loads handled by a straddle carrier operated by one man.

▶ **System in Action**—Ninety-five percent of the construction materials come to Institute via motor trucks which unload at the

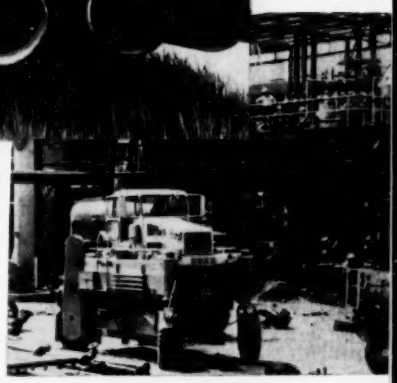
Open-air storage fits space-needs for large unit loads handled by big straddle carriers.





Using pallets or bolsters, straddle trucks move all pipe from storage to plant site.

Arriving at site, carrier drops load close to point of use.



Materials to Chemical Maker's New Plant Site

main store-room receiving dock, or directly at field storage area. The remaining 5% is delivered directly to the construction site.

When a delivery truck pulls in at the depressed receiving dock, hydraulic levelers operate to provide smooth entry for one of two 4,000-lb. capacity gas-powered fork trucks. Incoming items are loaded directly onto pallet on fork truck. If consigned to bin storage (small items packaged in cartons or drums), fork truck carries pallet into main store room.

Material assigned to field storage moves by pallet on fork truck to the materials shelter which is a roofed structure without walls located alongside the unloading dock.

▶ **Heavyweights Take Over** — Straddle carriers dominate the scene from this point on; they pick up loaded pallets at the materials shelter and deliver them to a 4-acre, slag-covered, open-field storage area. A crane and 3-man crew unload and palletize huge items which have been delivered directly to the field storage area by rail or truck common carrier. All pallets and bolsters move on straddle carriers from here to the plant construction site.

▶ **Mutt and Jeff Team** — Fork trucks and straddle carriers complement each other in Carbide's operation.

The two fork trucks handle short hauls and tier pallets, where needed. Their ability to handle any kind of palletized load enables them to cope with the great variety of materials received.

The two 30,000-lb.-capacity straddle carriers work as the prime horizontal movers. Their unique ability to pick up or deposit a load in a few seconds and travel with it at truck speed gives them a mobility which conventional trucks can't match. Working in the spacious open area, they can load and unload almost without stopping. And the entire operation of load-carry-unload requires only the single truck operator.

Like the fork trucks, straddle carriers carry any properly palletized load. But, they're particularly effective at hauling long sections of pipe and structural steel. Even so, they provide the delicate touch, too, by speeding pallets of "nuts and bolts" supplies to the construction site, on request.

Catalyst Key to New Chlorination Process

One of Germany's major chemical producers, Badische Analin-Und Soda-Fabrik, has obtained a preliminary patent on what it describes as an improved method for chlorinating hydrocarbons in vapor phase. Discovery, if it proves commercially feasible, will be of major importance in manufacturing chlorocarbon solvents such as carbon tetrachloride and perchloroethylene.

Heart of continuous chlorinating technique is the catalyst—rare metal chlorides (e.g., palladium chloride) on an aluminum chloride base. Catalyst is heated above boiling point of hydrocarbon in a fluidized bed, active coke added, then chlorine (mixed with inert gas like nitrogen) and hydrocarbon vapor are injected. Weight of catalyst is around 1.5 to 4.5% of hydrocarbon weight.

After initial heating, heat of reaction maintains operating temperature. Temperatures up to 440 F. are readily controlled by regulating chlorine input and recycling unreacted chlorine. Pressures can be varied, although atmospheric pressure seems to give best results, around 90% yields.

Catalyst life, according to BASF, is much longer than in other catalytic chlorination processes because no complex compounds are formed to block catalyst activity. Chlorination method can also yield paradichlorobenzene (used in mothballs) preferentially with a benzene feed.

BASF was not ready to discuss whether or not its development will find immediate application in any commercial installation.

New Aniline Plant Uses Catalytic Hydrogenation

Marking industry's swing to an attractive new process (Chem. Eng., Feb. 10, 1958, p. 69), American Cyanamid's new aniline plant at Willow Island, W. Va., uses fluid-bed reactor and a new catalyst to turn out 24 million lb./yr. of aniline via catalytic hydrogenation. Hydrogen comes from natural gas reforming. Other process users: Du Pont, National Aniline.

Eddy Current Brake Bridles Sodium Flow

Its two pole faces straddling the sodium coolant pipe on the Sodium Reactor Experiment (SRE), this eddy current brake above is the unique solution of engineers at Atomics International, Canoga Park, Calif., for controlling rate of temperature change in reactor's core. Brake operates so as to minimize thermal stresses which may be imposed on sodium piping systems.

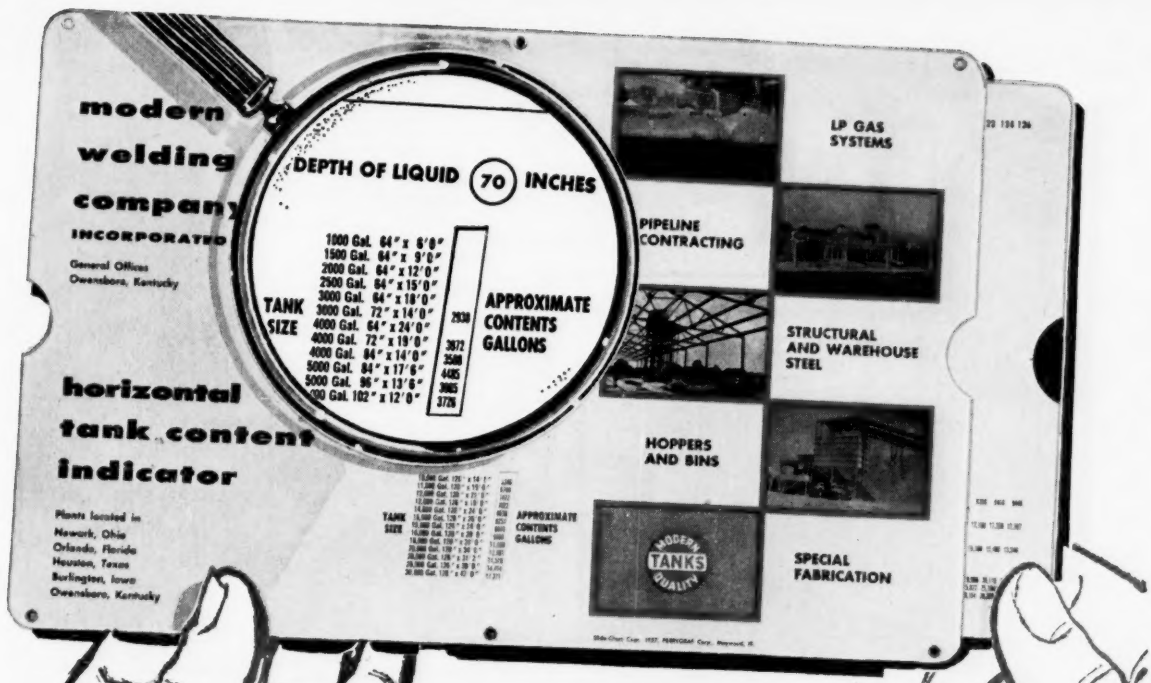
Two such brakes are installed on reactor system—one on the outlet side of the main heat exchanger (primary sodium flow system) and one on the secondary sodium flow system (nonradioactive side). These cut thermal stresses in the heat exchanger as well as in sodium piping systems.

►**Low-Stress Throttling**—Brakes are designed to throttle sodium flow from 1,200 gpm. to 12 gpm. within two seconds. Importantly, thermal stresses are far below those which could seriously affect piping.

Brakes operate at 500 F., which is temperature of the sodium returning to the core at full-power operation. (Full-power exit temperature from core is 960 F.) Sodium circulates under a driving pressure (convection head) of 0.3 psi.

Yoke of the magnetic pole faces consists of 11 laminations of 1-in. steel. It weighs 7,000 lb. and measures 50 in. high by 50 in. wide.

One significant feature of brake design is low power requirement—only 12 amp. dc. at 120 volts.



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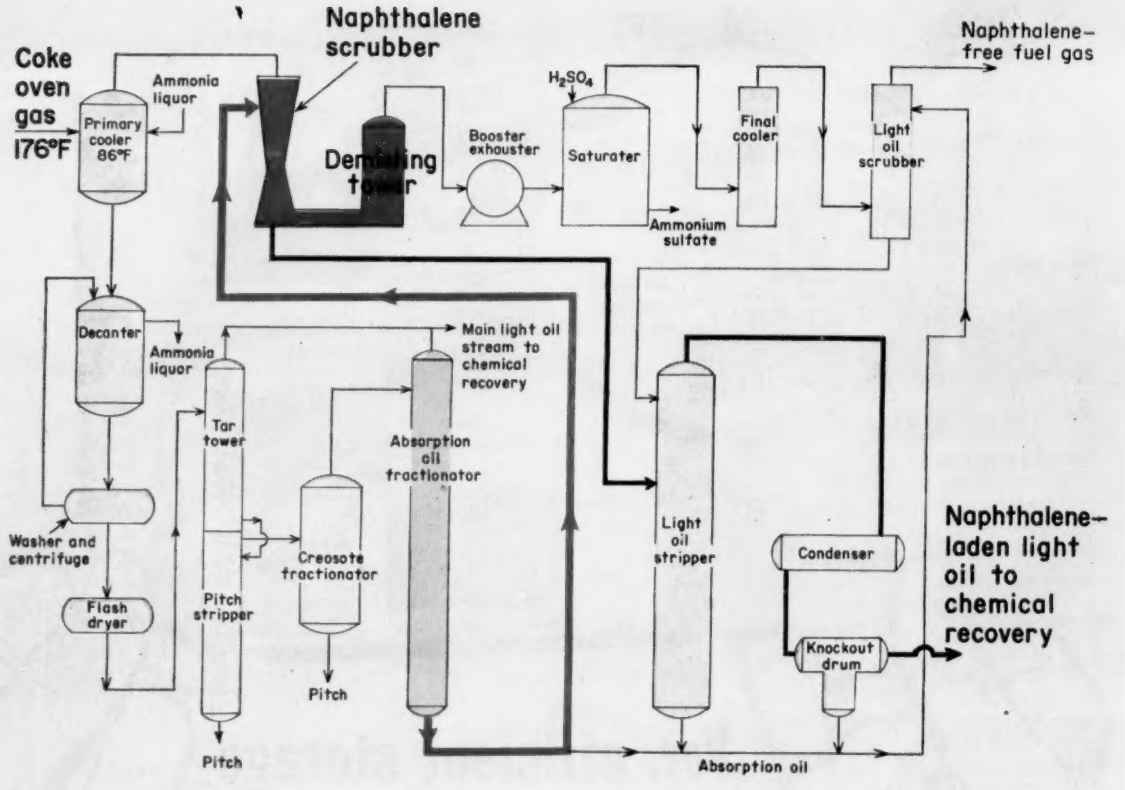

Scrubber Ends Coker's Naphthalene Woes

New coke-oven byproduct chemicals plant uses venturi scrubber to keep naphthalene from fouling mains and towers, gains reduction in recovery-tower size.

Next month, U. S. Steel Corp., Gary, Ind., will bring on stream at its new chemical recovery plant a new, perfected design of a naphthalene scrubber first used early last year.

Working on gas from the coke ovens, scrubber removes naphthalene which normally remains in the gas following cooling. No longer does naphthalene snow form to clog mains and towers downstream from the cooler.

In conjunction with its new scrubber, U. S. Steel is reaping benefits from two associated changes:

• New booster-exhauster discharges scrubbed gas at 12 psig., sufficient pressure to push it through final recovery steps, distribution and use as steel-mill fuel. Previously, USS used an extra boosting station to raise pressure of the chemical-recovery effluent gas sufficiently for distribution and use.

• Absorption oil for the naphthalene and light-oil scrubbers is a creosote distillate from the coal tar, first such use in the U. S. where paraffinic-base petroleum oils usually fill this job.

Because the naphthalene-free gas is at a higher pressure level than formerly, U. S. Steel can use a much smaller scrubber tower to recover light oil from the gas. And because there is no danger of plugging from naphthalene or polymerized petroleum fraction, tower uses more efficient sieve trays rather wooden grid packing.

▶ **Proper Sequence** — Conventional practice in coke-oven-gas cleaning lines finds the equipment train headed by a primary cooler followed by electrostatic tar precipitator, ammonia recovery, final cooler and light-oil scrubber.

U. S. Steel has replaced the precipitator with its scrubber, reducing naphthalene dewpoint below the 75-deg.-F. temperature of the final gas cooler. Finished fuel gas contains less naphthalene than discharge from a conventional gas-cleaning line which depends on the light-oil scrubber to remove naphthalene.

Elements of the gas-cleaning line other than the scrubber and the booster-exhauster remain the same as before.

▶ **Venturi Smites Fog** — In designing the scrubber, USS engineers experimented with various baffle arrangements and other types of internal construction. But final selection was a simple venturi scrubber.

Though it drops pressure about ¾ psi., the venturi costs

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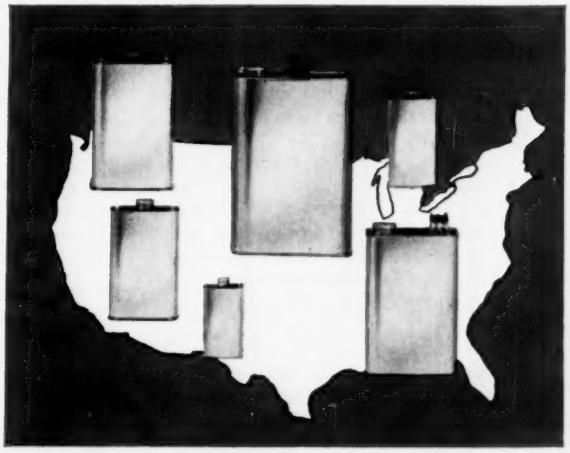

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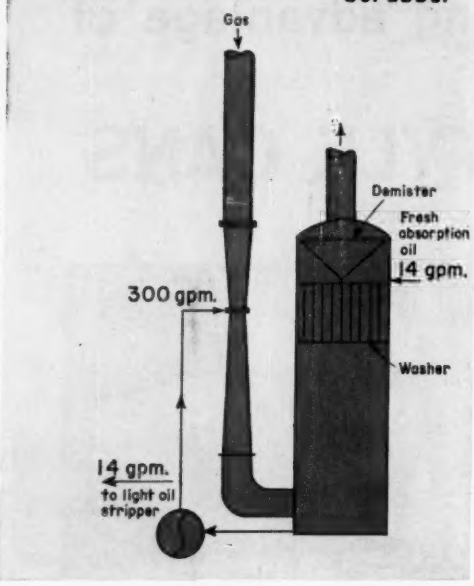
Final Design of Naphthalene Scrubber



substantially less than other scrubbers that were considered. And it proves able to do an excellent job.

▶**Down the Line**—Included in 227 million cu. ft./day of raw gases and vapors leaving the Gary coke ovens are 330,000 gal. of liquids—ammonia liquor, tar and light oil. Approximately 80% of the tar condenses in the gas collector mains and runs into a decantation system prior to refining.

Gas, containing the remaining tar, ammonia liquor and light oil passes into the primary cooler on the gas-cleaning line. Here, cooling liquor entering through a spray system at the top of the tower cools the rising hot gas from about 176 to 95 F. In cooling, volume of the gas shrinks while the cooling liquor picks up tar and ammonia liquor.

Leaving the primary cooler, gas still contains tar fog, naphthalene vapor, water vapor, ammonia and light oil. Entering the venturi scrubber, it contacts absorption oil which removes the remaining tar and naphthalene. Entrained absorption oil gets knocked out of the gas in the washing and demisting cyclonic-type separator immediately following the scrubber.

Next, the booster-exhauster raises pressure to 12 psi. Then, at a temperature of 212 F., gas passes through a saturator to contact 2% sulfuric acid and give up its ammonia which is recovered as an ammonium sulfate slurry.

Before recovery of the light fraction which contains benzene, toluene and xylene, the gas flows through a final cooler to drop temperature from 140 to 59 F. Then, it contacts absorption oil in a sieve-tray tower to give up its light oil content.

▶**Absorption Oil From Tar**—Main source of absorption oil for the naphthalene scrubber and the light oil recovery tower is the effluent from the primary cooler. It goes to a decanter for removal of ammonia liquor which passes to storage for recycle.

Decanter underflow is washed free of chlorides, centrifuged, run through a flash dryer and then pumped to tar tower operating at 446 F. Overhead light oils and naphthalene pass to a naphthalene distillation unit.

Heavier ends pass to a pitch stripper which drives off creosote overhead to another fractionator operating at 572 F. Overhead from this fractionator passes to the absorption oil fractionator which supplies oil to the gas cleaning line.

▶**Scrubber Discharge** — Oil from the naphthalene scrubber flows to the rich-oil storage tank where it mingles with absorption oil that has been circulated over the light-oil tower. The mixture will be fed to the light-oil stripping stills.

Direct Thermo-Electric Power Efficiency Upped

Direct conversion of heat into electrical power took a significant step nearer commercial use "in the near future," with a recent announcement that a working model has produced electrical power with thermal efficiencies of about 12%.

Described by patent applicants Joseph Kaye and George Hatsopoulos, professors of mechanical engineering at Massachusetts Institute of Technology, the system goes through the typical heat engine cycle of receiving heat at a high temperature and rejecting it at a low one. But, unlike the typical system it delivers work with no moving parts.

▶**Improved Conversion**—Apparatus is similar to that used by General Electric physicist Volney Wilson in recent experiments (*Chem. Eng.*, Jan. 13, 1958, p. 90). Wilson's system, however, boasts efficiencies of only a little over 8%.

MIT model consists of two plates in a vacuum tube; the hot plate (at about 2,000 F.) boils off electrons onto the colder plate and produces a current when the two plates are connected through an external circuit.

Eventually, Kaye and Hatsopoulos expect, efficiencies of about 30% may be achieved. It now appears, they add, that an efficient power plant could be built to yield 5,000 to 15,000 watts/cu. ft. of plant volume—ideal where small power plants are needed.

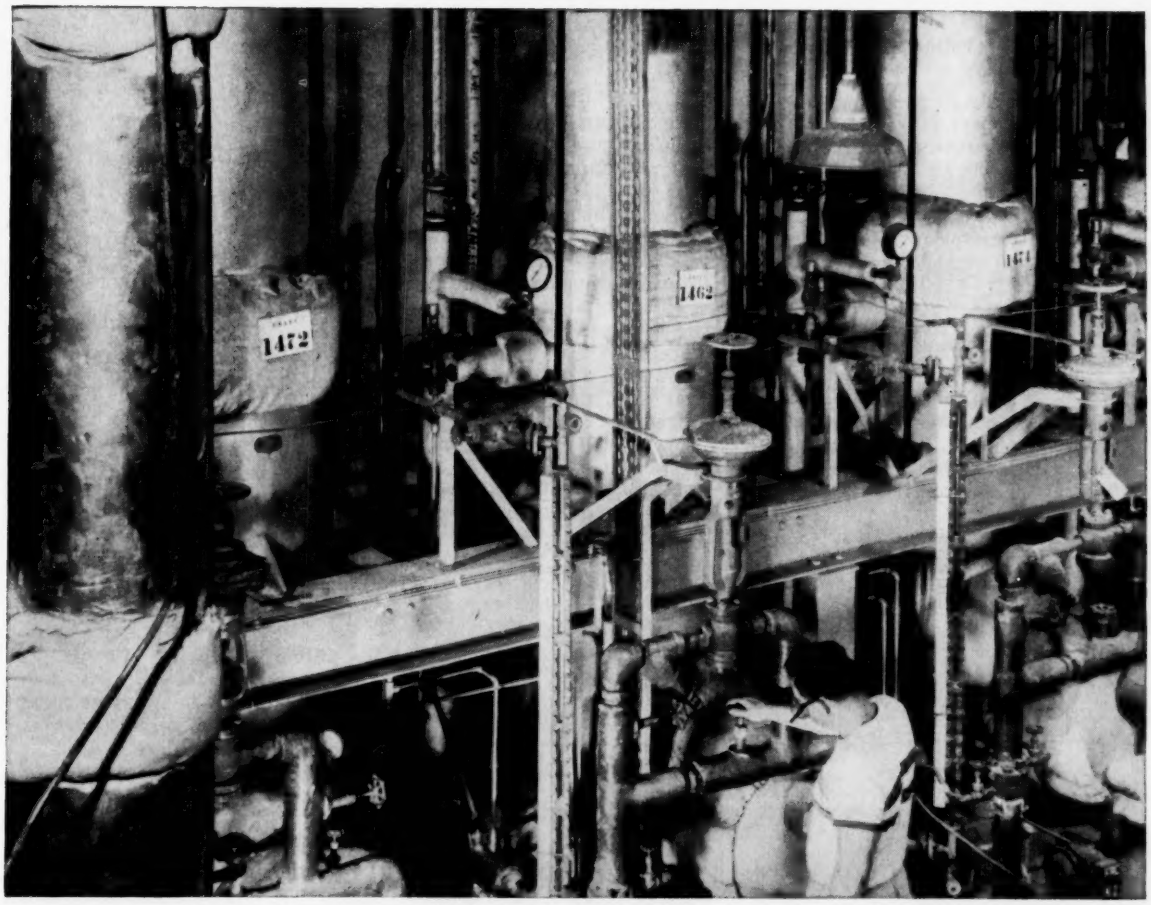
Dispersing Asphalt Licks Pulping Snag

One of the gummiest problems facing paperboard makers is asphalt coatings on some of the wastepaper stock that is fed to pulping machines: Asphalt flakes clog screens and felts and blemish finished board.

Instead of removing this asphalt before pulping, a tedious procedure, Federal Paper Board Co.'s mill at Steubenville, Ohio, takes the opposite tack: Particles of asphalt and other material are dispersed so finely through pulp that it can't gum up machinery or mar finished product. Process was licensed from Fibre Conservation Corp. of Chicago and engineered as a package by Black-Clawson Co.

Operating continuously, pulping system begins with removal of heavy foreign material in a Hydrapulper, ragger, junk remover and liquid cyclones. Stock consistency is increased by thickeners and ultimately raised to 30% in dewatering press ahead of the Pandia continuous digester. Steam at 60-70 psi. is injected into digester to raise temperature of stock to melting point of asphalt, facilitating its dispersion.

From digester tube, stock enters the Pandia discharger through a restricted orifice that minimizes steam loss at dis-



Monel nickel-copper alloy withstands corrosive fluoride attack in these series-connected towers for separating B-10 and B-11 isotopes found in natural boron.

Hooker "divorces" boron isotopes in unusual 350-foot, 6-tower, Monel fractionator

...gets 3 pounds per day of precious neutron-absorbing boron-10

The towers shown above are part of a six-tower fractionating system that may be the world's most effective. It is located in the AEC's Boron-10 plant, designed and constructed by Singmaster & Breyer and operated by Hooker Electrochemical Co.

In 350 feet of total height (they're connected in series) they enrich a dimethyl ether-boron trifluoride complex containing 18.8% B-10 to one containing 92% of this isotope.

Strangely, the separation of the B-10 and B-11 constituents does not depend on volatility. Instead it depends on a difference in the rates of association and dissociation of the DME-BF_3 complex. The lighter B-10 compound comes off in the liquid bottoms and the heavier B-11 compound in the vapor tops.

Corrosion potential is high

With fluorides at 105°C., and with the inevitable trace moisture present in a system of this type, a high corrosion potential is established.

For this reason, from the point where boron trifluoride enters the system via a Monel nickel-copper alloy reducing valve, most equipment is made of Monel* nickel-copper alloy ... tanks, columns, re-boilers, condensers, pumps, valves, piping.

Columns are filled with protruded Monel alloy packing

Monel alloy is highly resistant to the fluoride corrosion that is so often a problem in preparing isotopes and nuclear fuels. What's more, it has the high strength and fabricating properties needed for pressure vessels and allied equipment.

For technical assistance with your own corrosion problems, call on Inco's Development and Research Division.

*Registered trademark

The International Nickel Co., Inc.

67 Wall Street INCO New York 5, N.Y.

INCO NICKEL ALLOYS

charge point. At the same time, explosive effect of sudden pressure drop across orifice further disperses asphalt and tends to separate fibers.

To wind up process, stock is collected in cyclone tank, vented to atmosphere and regulated for consistency.

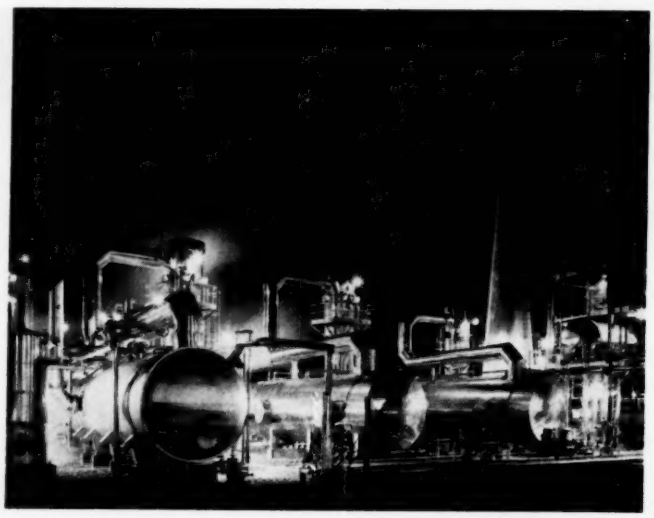
High-Flux Reactor Goes Critical at Oak Ridge

A new research reactor, operated by Union Carbide for the Atomic Energy Commission, has swung into operation at Oak Ridge, Tenn.

Reactor, officially titled Oak Ridge Research Reactor (ORR), is a high-flux, tank-type reactor immersed in a pool, a modification of Materials Testing Reactor originated at Oak Ridge National Laboratory. This newest reactor will be a guinea pig for fundamental research and engineering studies on effect of nuclear radiation on reactor materials, especially fuel elements and structural materials.

Engineering design emphasizes flexibility, permitting many kinds of experiments close to reactor core in high-flux region. Entire fuel systems, rather than single samples, can be placed in reactor's high-flux zone.

Vital statistics: ORR is a heterogeneous reactor (solid fuel) moderated and cooled with demineralized water. It is designed to operate at a power level of 20,000 to 30,000 kw. with an average thermal neutron flux greater than 1 x 10^{14} neutrons per sq. cm. per sec. Beryllium-reflected core utilizes enriched uranium plate-type elements of uranium-aluminum alloy clad with aluminum.



New French Plant to Make Sulfur From Sour Gas

First of three stages of a setup that will turn out 600,000 tons/yr. of sulfur by next April, installation above at Lacq, France, is now on stream producing 225 long tons/day, draws on recently found reservoirs of sour (15-17% H_2S) natural gas (*Chem. Eng.*, April 7, 1958, p. 58). Designed and built by Ralph M. Parsons Co., Los Angeles, and Heurtey et Cie., Paris, for Societe Nationale des Petroles d'Aquitaine, plant has horizontal burners (center), vertical reactors (right).

News Briefs

Solid-propellants: Hercules Powder Co. will build a major new facility at Bacchus, Utah, to develop and produce solid rocket propellant, will use latest methods for casting double-based solid propellants at a new site adjacent to present explosive plant.

Tanker-transported bitumen: Goldschmidt AG., Essen, West Germany, has built a tanker on the principle of the thermos bottle to bring liquid bitumen at roughly 200 C. from its refineries in the Ruhr to process plants in Mannheim, via a Rhine River journey.

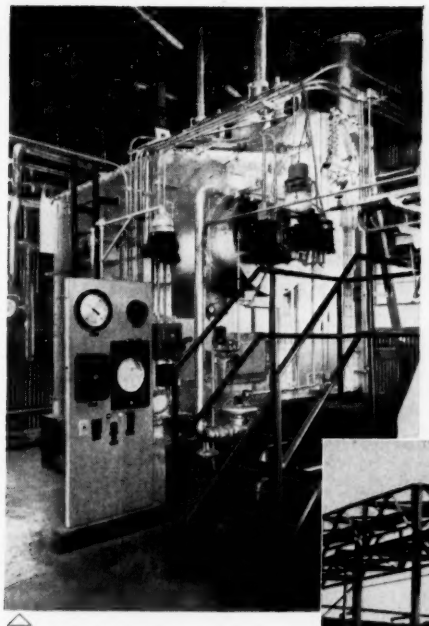
Beryllium: Mineral Concentrates, Inc., is building a $250,000 processing plant at Loveland, Colo., near Denver, to produce beryllium hydroxide from beryl ore. Five other companies are expected to mine beryl in the area. Plant is scheduled to go on stream next month.

Alkylated phenols: Imperial Chemical Industries is building a new unit at Billingham, County Durham, England, to make such alkylated phenols as octylphenol and nonylphenol.

Refinery: Texas Co.'s 80,000-bbl./day vacuum pipe still is now on stream at Port Arthur, Tex., and its 60,000-bbl./day cat cracker at the same site will be completed in a few months.

Methanol, ammonia: Olin Mathieson is shutting down government-owned methanol and ammonia units at Morgantown, W. Va. High operating cost and increasingly competitive markets are reasons given.

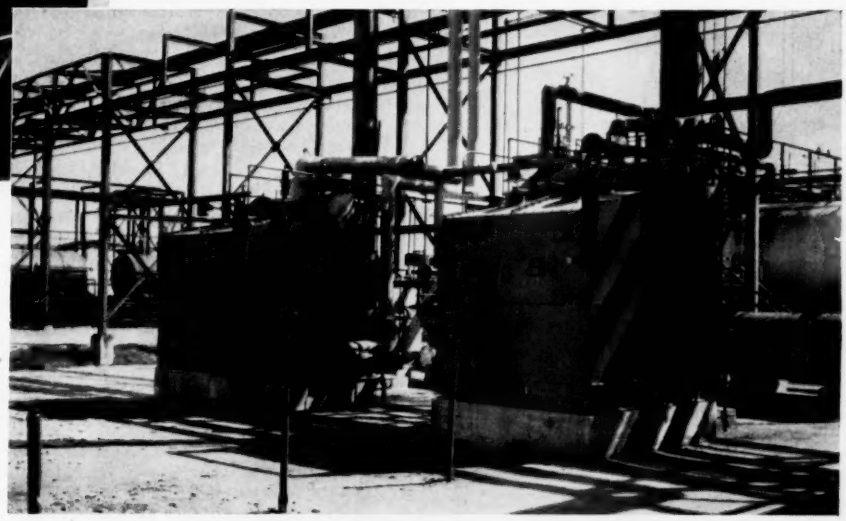
Distilling unit: British Petroleum has added a 2.2-million-ton/yr. crude distillation unit to its Lavera, France, refinery, near Marseilles, boosting annual capacity to 4 million tons.



INDOORS or OUT...

FW Vaporizers using Dowtherm* CUT COSTS of high-temperature, low-pressure heating

This 3,000,000 btu/hr vaporizer using Dowtherm was designed and built for the emulsifier plant of a large company in the south.



Two vaporizers using Dowtherm at a large industrial chemicals plant each supply 2,200,000 btu/hr, 650F, 58 psi for process heating.

...BECAUSE ONLY FW DOES THE COMPLETE JOB

✳ **Design and Engineering.** High temperature, low-pressure heating systems by Foster Wheeler are specially designed and engineered to meet your *specific process requirements* to best advantage.

✳ **Installation.** Foster Wheeler can supply and install the *complete heating system* — making sure that every detail of the installation is right for the job.

✳ **Operation.** Foster Wheeler responsibility follows through to the successful operation of the entire system. *Proper functioning* of all elements is positively assured.

✳ **Service.** Foster Wheeler's skilled engineers and service personnel are *available at all times* — to assure continued trouble-free operation or to assist in any process changes or relocation of equipment.

FOR 24 YEARS Foster Wheeler engineers have been designing and applying process heating systems using Dowtherm. These applications—over 500 of them—have been supplied with oil, gas or electrically heated units in capacities from 44,500 to 50,000,000 btu/hr and are operating at temperatures of approximately 500 to 720 F and pressures of approximately 1 to 113 psig. In every instance, the vaporizer unit was recommended only after the entire process heating system had been analyzed. This was the customer's assurance of a vaporizer that's right for the job.

We will be glad to study your requirements and point out how FW high-temperature, low-pressure heating systems will improve your process. For complete information, write for Bulletin ID-54-5. *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.*

*Reg. Trade Mark, Dow Chemical Co.

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Stronger Resin, Lasts Longer

New ion exchange resin's greater physical stability means longer life in home and industrial use.

Whiteness and exceptional strength are the earmarks of a new high capacity styrene-based cation exchange resin.

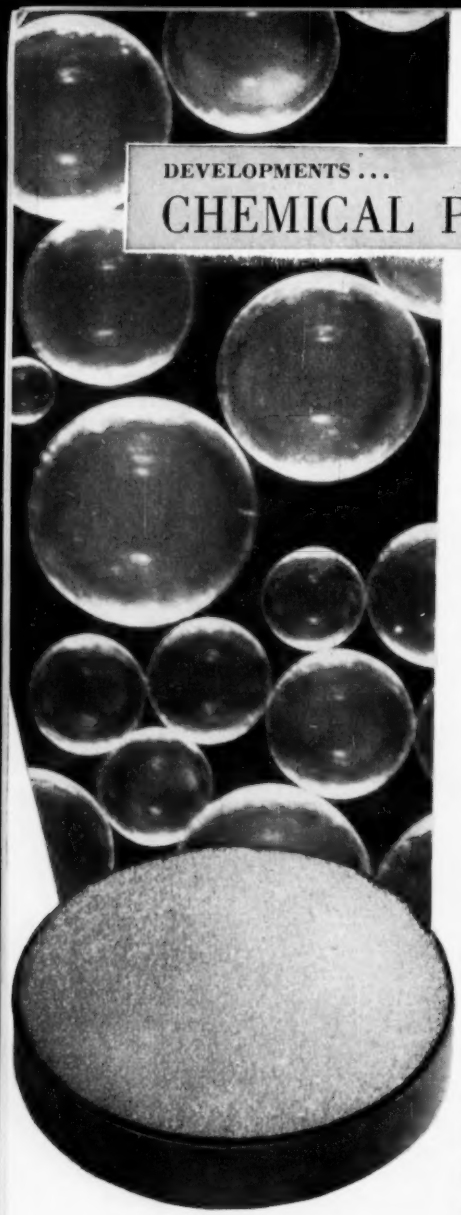
Reduction in attrition losses by as much as two thirds shows up in tests in industrial applications where such losses have been significant. Greatly reduced resin replacement has resulted from tests and field applications of the new resin in chemical processing applications where short cycles and high ionic concentrations are encountered.

In soft water service operations for home use, where a tank unit is exchanged, a large part of the makeup resin required is due to resin breakage. Estimates are that resin makeup made necessary by such breakage will be reduced by at least half by the use of the new resin.

The white color, as contrasted to the light brown of past resins, is expected to be attractive to the home market.

Called Dowex 50W, the product is a strongly acidic cation exchange resin comprising a styrene-divinylbenzene matrix, to which are attached ionizable or functional groups of nuclear sulfonic acid. This structure is said to give maximum resistance to oxidation, reduction, mechanical wear, and breakage, and is insoluble in all common solvents.

Greater physical stability of the beads, attributed to less internal stress, does not decrease ion exchange capacity.



Whiteness plus strength-producing freedom from internal stress distinguish new styrene-based ion exchange resin.

Older resins' light brown color lessens appeal to home water-softener users; lower strength requires more resin makeup.

Selecting A Motor Drive For A Hazardous Area?

Here's how

TEIGF motors

by E-M

provide safe, dependable, economical power

Faced with the problem of driving hydrogen compressors in atmospheres which might contain hydrocarbons at their Baltimore refinery, engineers of Esso Standard Oil Company turned to TEIGF (Totally Enclosed Inert Gas Filled) Motors. Horsepower requirements exceeded the practicable limits under which explosion-proof motors could be used.

An important consideration was getting the greatest possible drive economy while operating safely in a possible hydrogen atmosphere. Three E-M 350 hp, 390 rpm TEIGF Motors are on duty at Esso Standard Oil Company fulfilling these important qualifications.

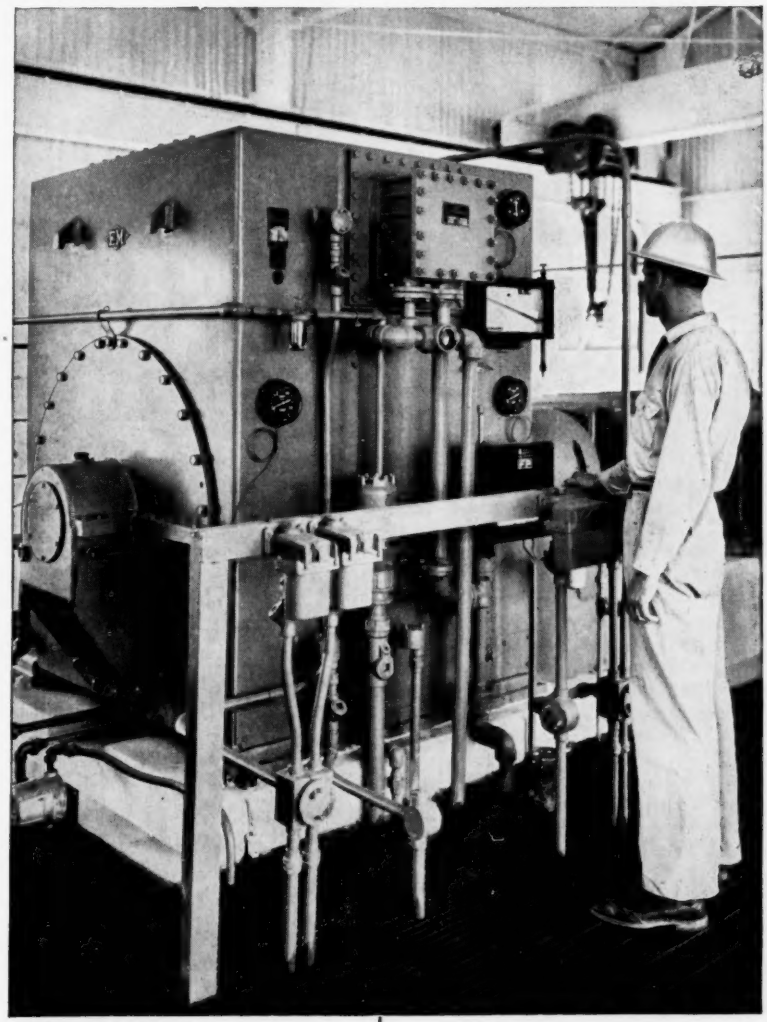
For Esso Standard Oil Company and other companies with similar problems, these E-M Motors offer three main groups of advantages:

1. SAFETY — Within the motor enclosure, inert gas pressure above atmospheric keeps explosive hydrogen *out*. A series of features help accomplish complete safety . . . inert gas pressure gauges . . . temperature gauges . . . purging valves, etc. and a full line of optional equipment. The E-M TEIGF Motor can be "customized" to meet your needs exactly.

2. RUGGED DEPENDABILITY. E-M uses specially designed "box type" frames of heavy-duty plate steel reinforced with heavy bar-stock ribs. They cannot twist or distort. Air gap is accurate and permanent, as all frame welding is completed before precision boring. Ventilating gas passages are carefully engineered to provide unimpeded gas flow for optimum cooling.

3. ECONOMICAL OPERATION. In E-M TEIGF Motors, gas loss is lower than commercially accepted standards. Specially designed shaft seals are oil-pressure gas-sealed bearing type, virtually non-wearing. Where bolts enter outside casing, E-M engineers specify blind holes . . . tapping and drilling are done *into* casing, not through. Operating and maintenance costs are at a minimum.

Consult your nearest E-M sales engineer, or write the factory for TEIGF Motor Bulletin No. 226.



TYPICAL STANDARD FEATURES INCLUDE:

1. Top-mounted gas-to-water cooler for use with suitable cooling water supply.
2. Forced-feed lubricated bearings and oil-pressure gas seals.
3. Oil pump, motor and oil filter. (Can be supplied optionally inside enclosure.)
4. Inert-gas temperature gauge.
5. Inert-gas pressure gauge.

(additional features shown in Bulletin No. 226)

TYPICAL OPTIONAL FEATURES INCLUDE:

1. Water cooler with double-tube construction for added protection against leakage.
2. Liquid level detector switch. Accumulation of moisture within motor sounds alarm or shuts down motor.
3. Bearing temperature relays, to sound alarm or shut down motor.
4. Explosion-proof motor terminal pothead or inert-gas filled terminal box.
5. Water flow indicator. Can be adapted for use with pneumatic-type regulating device.

ELECTRIC MACHINERY MFG. COMPANY

MINNEAPOLIS 13, MINNESOTA

Specialists in making motors do

EXACTLY WHAT YOU WANT THEM TO

1300—TPA—2179

Dowex 50W also has low heavy metal content which makes it desirable for certain catalytic uses like epoxidation. —**Dow Chemical Co., Midland, Mich.** 74A

Fluorocarbons

New series of fluoroalcohols; new fluorine-carbon insulating gas.

A new series of high solvency, fluorine-containing alcohols provide a convenient means of introducing fluoroalkyl groups into an organic molecule. And they show promise as intermediates in development of new plastics, surface active agents, lubricants, elastomers, and plasticizers with exceptional thermal and chemical stability.

Outgrowth of ten years of research on the free radical telomerization of tetrafluoroethylene in methanol, the fluoroalcohols are being offered in development quantities. Initially, two compounds—C_3 fluoroalcohol and C_5 fluoroalcohol—are available at $30/lb.

Representing the lowest members of a series of trihydrofluoroalcohols containing an odd number of carbon atoms, the fluoroalcohols undergo reactions characteristic of primary alcohols. They are, however, about 10,000 times more acidic than ethanol and may require modification of conditions generally used with hydrocarbon alcohols to attain similar chemical reactions.

Another fluorocarbon, octafluorocyclobutane, may soon make possible more reliable, lighter weight electrical equipment, capable of handling higher voltages. Experimental quantities of the colorless, odorless, nonflammable gas are now available and the manufacturer is prepared to go into commercial production when sufficient demand warrants it.

Research by leading electrical manufacturers show it to be a promising improvement of sulfur hexafluoride when used as a dielectric or insulating gas in high-voltage electrical equipment.

It is an electronegative gas with a strong affinity for electrons. This combined with its high molecular weight and chemical stability even at elevated temperatures accounts for its outstanding dielectric properties.—**Du Pont Co., Wilmington, Del.** 76A

Acetylene Homolog

Methylacetylene - propadiene now commercially available.

Volume production of methylacetylene-propadiene has been started. A non-corrosive liquefied petroleum gas, it is a mixture of methylacetylene (about 70% by weight) and its isomer, propadiene (30%).

Fields in which it may find use include synthetic rubber, textiles, agricultural herbicides, pharmaceuticals and plastics. Application of the product as an intermediate for methacrylonitrile, methacrylates and propargyl alcohol appears to be a definite possibility. Because of its thermodynamic characteristics, it shows promise as a specialty fuel where controlled decomposition, low critical compression and low ignition energy are required.

Methylacetylene - propadiene has been found to undergo numerous reactions similar to those of its homolog, acetylene. In numerous cases, it reacts in a manner similar to that of its corresponding alkene, propylene.

Tank car price is 23¢/lb.—**Dow Chemical Co., Midland, Mich.** 76B

BRIEFS

Synthetic rubber, like butyl a low unsaturation polymer with superior air-holding and anti-ozone resistance, has been developed. Called MD 551, it withstands high temperatures so well that curing press bladders made of it last three times as long as conventional bladders (bladders are used in tire manufacture).—**Esso Research & Engineering Co., New York, N. Y.** 76C

White carbon black is now being made in this country. Essentially pure silicon dioxide, it has been imported from Germany and sold under the name Cab-O-Sil since 1953. Present uses include: reinforcing rubber polymers, stabilizing lubricating greases.—**Godfrey L. Cabot, Inc., Boston, Mass.** 76D

Polyethylene-carbon black composition with improved strengh and resistance to heat and greatly reduced environmental stress cracking has been developed. Improved properties plus the ability to load polyethylene with up to 80% carbon black, in contrast to 2-3% normally added simply for ultraviolet and weather protection, is due to chemical cross-linking of the two materials. Making cross-linking possible: Di-Cup, Hercules' dicumyl peroxide and Sterling MT, Godfrey L. Cabot's thermal carbon black. —**Hercules Powder Co., Wilmington, Del.** 76E

Triethylborane can now be supplied in 20-ml. sample quantities and larger quantities will be available this summer. A catalyst for polymerization of unsaturated monomers, it may have use as a jet fuel because of its unusual combustion properties. — **Callery Chemical Co., Pittsburgh, Pa.** 76F

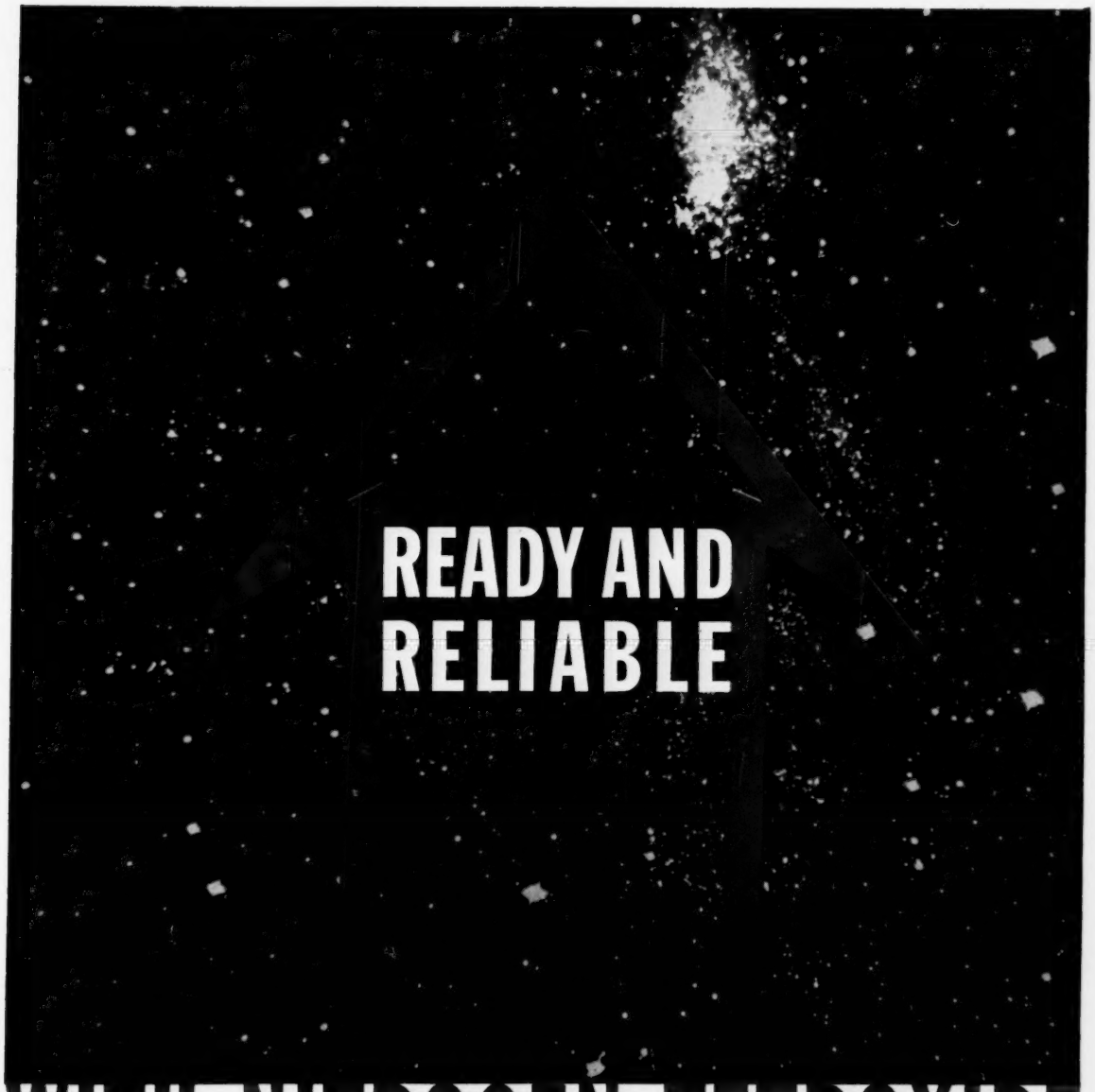
Solvent-free epoxy coating reduces fire hazard during application, eliminates pin-holing because there's no solvent to escape, permits thicker coatings per spray-gun pass because of high solids content. — **Shell Chemical Co., New York, N. Y.** 76G

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p. 225)



WITH NITROGEN TETROXIDE

. . . Requires no refrigeration . . . Easier to store than liquid oxygen

Performance of Nitrogen Tetroxide as an oxidizer for many fuels is comparable to that of liquid oxygen. In convenience it is far superior to liquid oxygen.

N_2O_4 can be shipped easily and stored indefinitely without refrigeration in ordinary carbon steel containers. It is a dense, mobile liquid that is noncorrosive if kept dry. The quantity of oxygen contained per unit volume of N_2O_4 is 1.01 Kg/liter at 20°C.

N_2O_4 is available in tonnage quantities from Allied's Hopewell, Virginia plant. For experimental purposes, N_2O_4 is available in 125 lb. cylinders and 2000 lb. containers. Write for technical data, and information on prices and delivery.

N_2O_4 Oxidant for liquid rocket propellants

Molecular weight	92.02
Boiling Point	21°C
Freezing Point	−11.3°C
Latent Heat of Vaporization	99 cal/gm @ 21°C
Critical Temp.	158°C
Critical Pressure	99 atm
Specific Heat of Liquid	0.36 cal/gm −10 to 20°C
Density of Liquid	1.45 gm/ml at 20°C
Density of Gas	3.3 gm/liter 21°C, at 1 atm
Vapor Pressure	2 atm at 35°C

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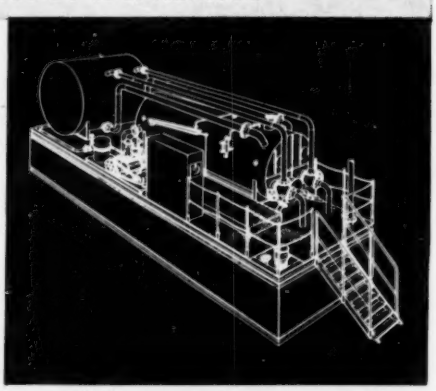
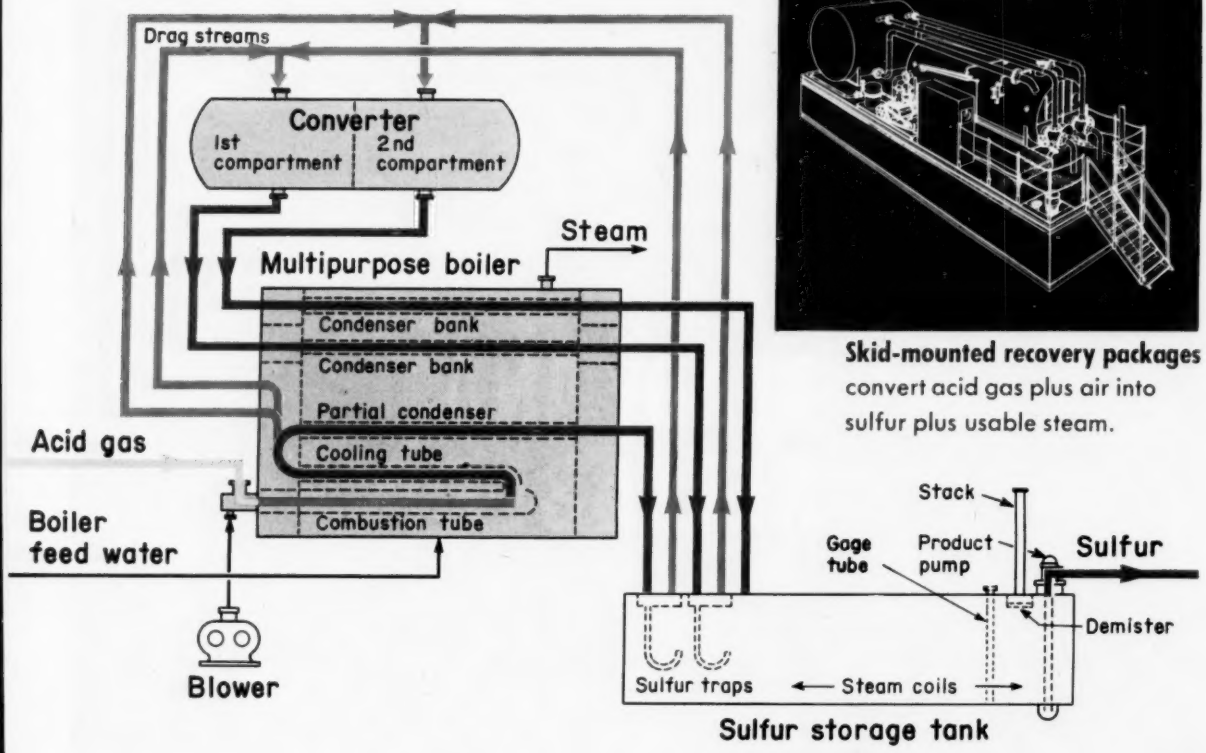


Skid-mounted recovery packages convert acid gas plus air into sulfur plus usable steam.



Packaged Unit Wrings Sulfur From Acid Gas

Here's a sulfur recovery unit that arrives at your plant ready for use. Take your pick—outputs range from 3 to 50 tons/day of molten product.

Money pours down the drain when acid gas goes up the stack. But up to now, the poor fellow who wasted less than 20 tons/day of sulfur couldn't find the economical stopper. And in recent times, the problem has grown more pressing because of greater emphasis against air pollution by civic groups.

Tears Engineers, a Dallas engineering firm, has come up with the answer—low-cost packaged sulfur recovery units that can solve the problem at a profit.

Mounted on skids, the various-size systems feed on acid gas streams of 25-100% hydrogen sulfide content, and deliver 3 to 50 long tons/day of high-purity molten sulfur. Conversion efficiencies are extremely high, and operating costs surprisingly low. Tears claims that the plants pay out in one to two years, before taxes, even if no credit is taken for nuisance abatement.

▶ **Redesign Did the Trick**—The well-known, near-classic Claus process, introduced into the U. S. in 1944, forms the basis for the unit's design. In operation, one-third of the feed H_2S burns with air to give sulfur dioxide. Then, the remaining H_2S reacts over a catalyst with the SO_2 combustion product to form elemental sulfur and water.

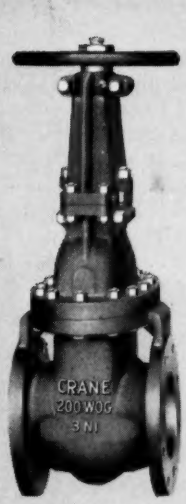
Most oil field and refinery sulfur-recovery units in operation today use the Claus process. But these units are large in size, and in past experience have proven uneconomical for less than about 20 tons/day.

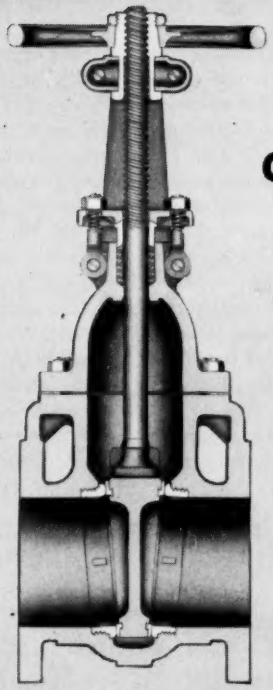
Pan American Petroleum Corp. devised the process equipment modifications that now permit handling of as low as 3 tons/day. Pan American has one unit in operation; a second is under construction.

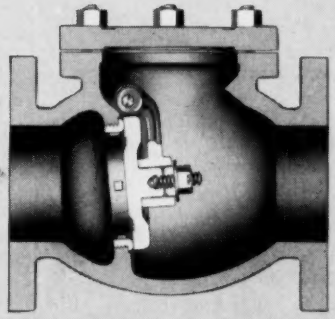
Working under a license from Pan American, Tears further redesigned the process to its present skid-mounted configuration. Several major oil companies and

NEW CRANE VALVES FOR PROCESS INDUSTRIES

3% NICKEL ALLOY CAST IRON







Gates and Swing Checks

18-8 SMo (Type 316) Alloy Trimmed

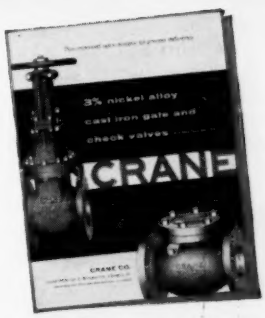
11 SIZES — 2 TO 18 INCHES

Better Corrosion Resistance . . . Longer Life . . . on More Fluids

This metal—Crane 3% nickel alloy iron—was developed especially to extend the usefulness and economy of cast iron valves in the process industries.

At but slightly higher cost, Crane 3% nickel iron valves provide substantially better resistance to corrosion than ordinary cast iron, and they have notably higher physical properties. Efficiency is stepped up further with Crane 18-8 SMo (Type 316) stainless steel trim.

Typical Recommended Applications: You will save with these valves —in the petroleum industry, for example—on oils containing traces of mineral acids; in wood-treating processes—on creosote vapors and oils; in pulp and paper mills—on alkaline liquors of various kinds. In general, they should be considered where all-iron or brass-trimmed iron valves are subject to seat corrosion.



ASK FOR THIS CIRCULAR

Complete technical and specification data on these valves are given in Circular AD-2313. Ask your Crane Representative for a copy, or write to address below.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill.—Branches and Wholesalers Serving All Areas

chemical firms are now considering purchase of the package.

▶ **More About the Package** — The plant's compactness and economy rests in clever design of the key item of equipment—a multipurpose vessel, which is essentially a marine-type boiler with several take-off connections on the five-pass tube side. This one item of equipment:

- Burns part of feed to produce SO_2.
- Reacts some H_2S and SO_2 non-catalytically to yield part of product sulfur.
- Condenses sulfur vapor from catalytic converters.
- Converts all combustion and reaction heat into usable steam.

Supplementary equipment includes the two-compartment converter containing bauxite catalyst; a sulfur storage-tank-separator combination; a positive-displacement air blower; and controls, piping and skid-type foundation.

▶ **Here's How It Works**—Feed gas and air enter the first pass (combustion tube) of the boiler through a special burner tip. This tip meters one-third of the acid gas directly into the fresh air stream to produce required SO_2. Remaining acid gas flows into the tube along a different path.

Effluent from the second pass (cooling tube), containing some sulfur vapor from noncatalytic reactions in the first two passes, flows through the third pass (partial condenser) and into the storage tank for separation of liquid sulfur. Sulfur separated at this point amounts to about 40% of recoverable product.

Gases from the storage tank mix with a drag stream of hot effluent from the second pass, and react over the catalyst in the first compartment of the converter to form more sulfur. This sulfur condenses in the fourth boiler pass (condenser bank), and drops out in the storage tank. The conversion cycle repeats again, this time in the second converter stage and fifth boiler pass. Left-over gas leaves the plant through a mist eliminator and disposal stack.

The boiler uses combustion and reaction heat to generate about 250 lb./hr. of 20- to 45-psig. saturated steam for every long ton of daily production.

▶ **Different Models Available**—Standard single-skid units can handle 3 to 12 long tons/day of sulfur. The largest unit in this class measures about 30 ft. long and 10 ft. wide. Its operating platform would be 4 to 5 ft. from the ground.

For larger users, Tears offers plants in which individual equipment items or combinations of items are skid-mounted. The largest multiskid plant can produce about 50 tons/day. Above this size, boilers are too cumbersome for skid mounting.

Units are also available for feeds with as low as 10% H_2S, but in this range economics become less attractive. — **Tears Engineers, 4617 Cole Ave., Dallas 5, Tex.** 78A

Equipment Developments

	Page number is also Reader Service Code number
Skid-mounted unit recovers sulfur from acid gas	78A
Plastic ball valve available in sizes to 3 in.	80A
Transfer valve regulates non-corrosive gases	80B
Giant electric motor drives natural gas compressor	82A
Dispersion mill homogenizes, disperses, or wet-mills	82B
Scrubber line uses no nozzles or pumps	82C
Emergency sealing compound adheres to all surfaces	82D
Sonic sifter boasts power savings and high capacity	84A
Angled nozzle provides full-cone spray	84B
Cork gasketing material resists fungus and ozone	84C
Fume scrubber constructed entirely of rigid PVC	84D
Generator converts electrical power to steam	84E
Vacuum tumble dryer comes in 14 sizes	84F
Diaphragm valve operates up to 400 F. and 150 psi.	84G
Projection paper for microfilm reproduces duplicates	84H
Remote tank-gage system has accuracy of 1/16 in.	84I
Tapered plugs seal leaking tubes	84J

For more details, use Reader Service Card

Plastic Ball Valve

Lightest and most compact PVC valve.

Newest offering by Goodrich is the new Koroseal polyvinyl chloride ball valve.

The self-lubricating unit features Teflon seats that never stick or gall, and also easy take-up to compensate for wear. Union coupling nuts at each end of the all-plastic valve also permit complete disassembly for repair.

Available with either threaded or socket end-connectors, the valves come in sizes ranging from ½ to 3 in. Recommended working pressures vary with temperature. — **Plastics Div., B. F. Goodrich Industrial Products Co., Marietta, Ohio.** 80A

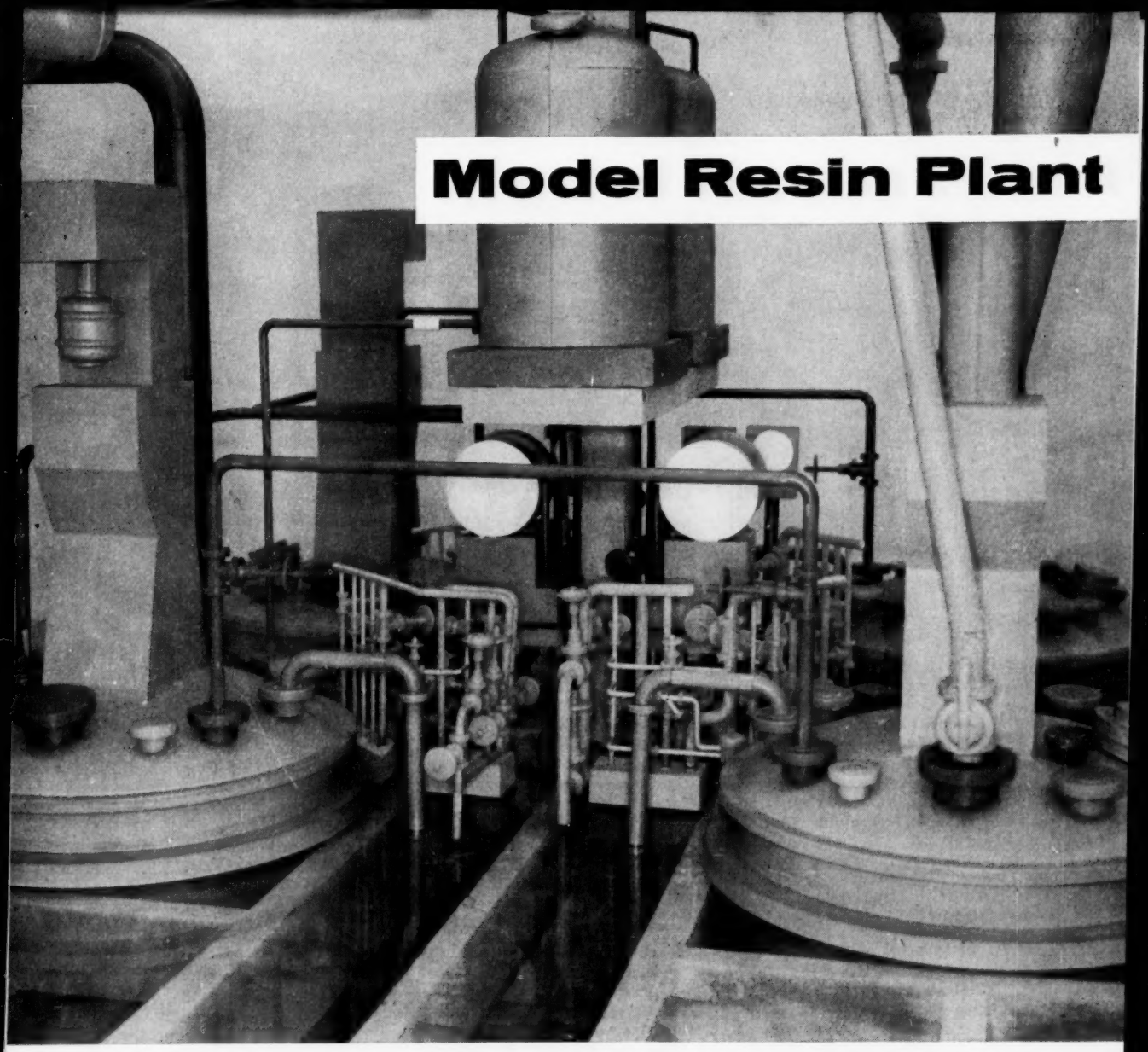
Transfer Valve

For precision control at high capacity.

Originally developed for pressurized transfer of missile fuels, a new AiResearch single-stage valve also offers pressure regulation and shutoff service for industrial non-corrosive gases.

Highly responsive and accurate, the unit is reported to be particularly useful for tight shutoff with minimal overshoot in dead-end service. And, in event of diaphragm failure, some models shut down in less than 0.1 sec.

Valves will reduce pressures as high as 3,500 psi. down to 10-250 psig. Flow capacities to



Model Resin Plant

For CIBA Company, Inc. in association with Toms River-Cincinnati Chemical Corporation, The M. W. Kellogg Company is engineering and erecting a new Araldite epoxy resin plant. The detailed model of reactors, valve manifolds, and other equipment pictured above, has long since paid for itself in developing design details and facilitating CIBA's review and approval.

Now an integral part of Kellogg's plant engineering and construction service to industry, the building and application of scale models save time and money in many ways for both customer and contractor. Introduced by Kellogg as a design tool, these models express engineering concepts better; achieve engineering, procurement, and construction goals faster; make the route between plant planning and plant production shorter and surer.

THE M. W. KELLOGG COMPANY, 711 THIRD AVE., NEW YORK 17

A SUBSIDIARY OF PULLMAN INCORPORATED

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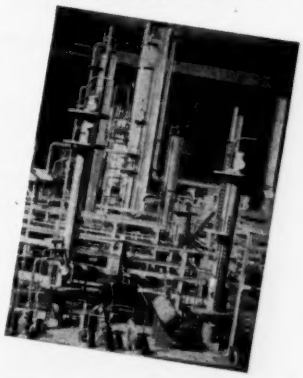
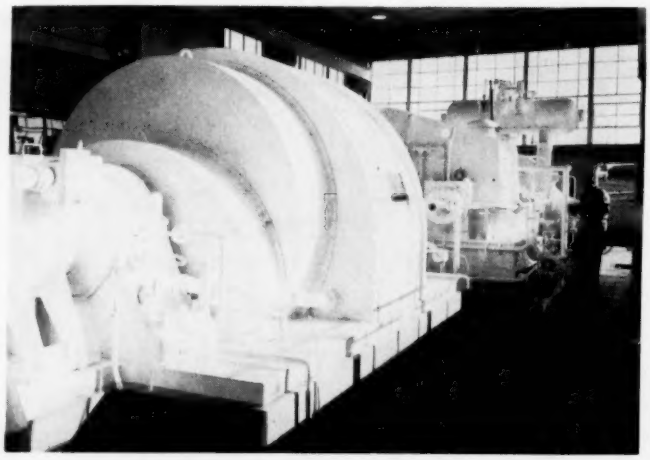
12-PAGE MODEL BOOKLET



This recent issue of the Kelloggram is devoted entirely to scale models and their use as a tool for better plant design. Many examples, together with construction techniques, are discussed and illustrated in detail.



Giant Electric Motor Aids in Gas Transmission

This 15,000-hp. synchronous electric motor, driving a single centrifugal compressor, helps to push natural gas along Texas Eastern Transmission Corp.'s 6,000-mi.-long pipeline. The motor-compressor combination, one of three now in service along the 30-in. trunk line extending from Mississippi to Pennsylvania, promises to add efficiency and economy to the company's operations. Developed jointly by Westinghouse and Texas Eastern engineers, the combination features a special gear box that steps rotor speed of 900 rpm. up to compressor speed of 6,506 rpm. — Westinghouse Electric Corp., Pittsburgh, Pa. 82A

30,000 scfm. of −250 to +250 F. gas are available.—**AiResearch Industrial Div., The Garrett Corp., 9851 Sepulveda Blvd., Los Angeles 45, Calif. 80B**

Dispersion Mill

Operates on either continuous or batch basis.

Applications for the completely new PUC Multistage Dispersion Mill include improved methods of wet milling, homogenizing, dispersing and emulsifying.

Acting as its own pump, the mill draws feed down through the grinding area, which consists of the gap between a rotor and a stator. Both rotor and stator have multistaged matching grooves; a calibrated adjustment sets the clearance between the two parts. High-frequency, rhythmic vibrations, produced within the milling stages, perform the grinding and dispersing action.

The mills come in several models, and with varying numbers of stages, depending on feed properties. Capacities range from 44 to 30,000 lb./hr. —**The Pfaudler Co., 1062 West Ave., Rochester, N. Y. 82B**

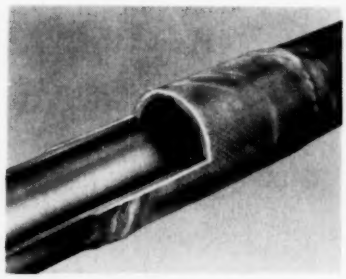
Scrubbers

New line comes in wide capacity range.

Wheelabrator now offers a wet dust collector that uses no nozzles or pumps, and delivers discharge air free of entrained water. Extensive testing during development showed high scrubbing efficiencies.

In operation, a slinger—the only moving part—throws a water spray that prewets incoming dust-laden air. Cyclonic action drops out some of the heavier dust particles. The air-dust stream then impinges on a water surface, reverses direction, and leaves the unit after passing through a baffle section and expansion chamber. Automatic sludge ejection is optional.

Designed to operate between 3 and 6 in. static pressure, the collector comes in a range of 12 overlapping sizes varying in capacity from a low of 1,080-1,600 cfm. to a high of 22,000-33,700 cfm. — **Wheelabrator Corp., 1034 Byrkit St., Mishawaka, Ind. 82C**



Emergency Sealer

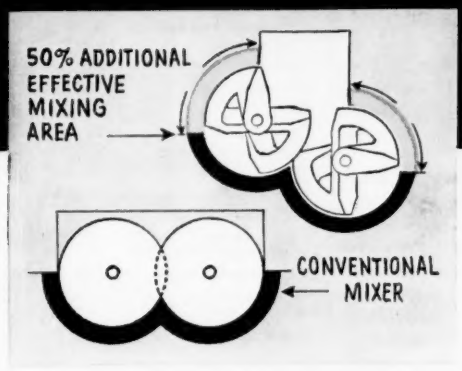
Gets equipment back into service fast.

Equipment can be back in service within an hour after damage when repaired with Homalite 345, a new epoxy-based sealing compound. It forms a strong, impact-resistant seal that stands up under corrosive and abrasive conditions. And, it will adhere to any clean, dry surface.

The procedure for repair of leaky pipelines, broken castings or corroded sheeting is simple. Apply a layer of sealing compound on the equipment's surface—then a layer of glass cloth—then another layer of sealer. Additional layers give extra strength.

Homalite 345 is useful for temperatures up to 150 F.; other formulations are available for higher temperatures. The manufacturer offers a sample repair kit for experimentation.—**The Homalite Corp., 15 Brookside Dr., Wilmington 4, Del. 82D**

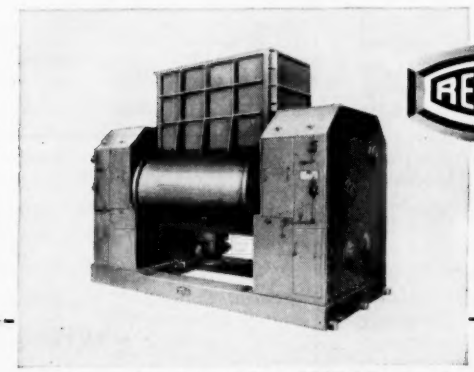
take this unique design... PRESTO! a much faster mix!



with Readco's unique split-level bowl: complete dispersion, shorter cycle, lower cost

The special design of this Readco mixing bowl provides a 50% greater effective mixing area. Overlapping sigma arms operate at minimum clearance from the shell, prevent build-up of materials, speed dispersion. The design also permits maximum heat transfer from the jacket.

You'll get complete dispersion, consistent mixing, in substantially shorter cycles. Working capacities range from 150 to 900 gallons. Write for complete information.



Whatever the mixing job: a READCO mixer!

READ STANDARD

York, Pennsylvania

A Division of

Capitol Products Corporation

Sonic Sifter

New line of sifting machines cuts power waste.

Less than one-third the power for capacities up to five times those of present-day mechanically activated sifting machines: —That's what United Specialties Co. claims about its new Novo sonic sifter. The sifter, which was developed in Germany by Rhewum, has found wide acceptance in many segments of European industry. United now has exclusive U. S. license.

Power savings hinge on the method of energy input. Actually, the mesh of the screen itself vibrates, whereas the frame holding the screen remains stationary. In operation, an electromagnet transmits vibration energy of a fundamental frequency to the screen. Superimposed on the fundamental is a series of harmonics which build the basic oscillation to more than 6,000 cps. These oscillations or ripples carry to all parts of the screen, leaving no dead areas of space.

Novo sifters show an ability to separate ½-in.-dia. particles and larger, to as fine as 30 microns. Output flow rate varies with the product and its final mesh. United is also marketing other new sonic machines, including a filter, a wet screen and lab analysis equipment. A mobile unit including all machine models is available for demonstrations at plant sites of potential buyers. — **United Specialties Co. of Illinois, Industrial Enterprises, Inc., Chicago.** 84A

BRIEFS

A spray nozzle for limited-space installations comes with a 90-deg. elbow turn and provides a full-cone spray pattern with uniform distribution. Offered in spray angles of 65 and 120 deg.—**Spraying Systems Co., 3275 Randolf St., Bellwood, Ill.** 84B

Gasketing material, a composition of cork and an elastomeric binder, offers a combination of impermeability, conformity and chemical inertness. It is extremely resistant to fungus and ozone attack.—**Armstrong Cork Co., Lancaster, Pa.** 84C

Fume scrubber, now fabricated entirely of rigid polyvinyl chloride, resists corrosion by halogens, ammonia, and hydrochloric and sulfuric acid fumes.—**Shutte and Koerting Co., Cornwells Hgts., Bucks County, Pa.** 84D

Steam generator needs only city water and electrical power inputs to give output of low pressure (0-15 psig.) or high pressure (100 psig.) steam. Size ranges from ½ to 5 hp. — **Electro-Steam Generator Corp., 2012 Duke St., Alexandria, Va.** 84E

Vacuum tumble dryer makes possible the drying of heat-sensitive materials in a fraction of standard time. Fourteen models, with capacities from 1 to 150 cu. ft., are available. — **The Patterson-Kelley Co., Inc., East Stroudsberg, Pa.** 84F

Diaphragm valve for the control of slurries and sludges operates up to 400 F. and 150 psi. without plugging. Available in either direct or reverse-acting models, it comes in a wide range of materials. — **Kriep Associates, Grist Mill Rd., Dover, N. J.** 84G

Projection paper makes it possible to produce high-contrast enlargements of engineering drawings from microfilm negatives. Enlargements, which are translucent, are useful for reproducing duplicates on a direct process machine.—**Graphic Reproduction Sales Div., Eastman Kodak Co., Rochester 4, N. Y.** 84H

Remote tank-gage system, called the Data-Gage, measures the liquid level in distant tanks, and telemeters depth to a control consol. System has capacity for 100 tanks, 0 to 64 ft. level, with an accuracy of $\frac{1}{16}$ in.—**Texas Instruments Inc., Industrial Instrumentation Div., 3609 Buffalo Speedway, Houston, Tex.** 84I

Tapered plugs for sealing off corroded or leaking exchanger and condenser tubes are available in sizes from ½ to 1½ in.—**Nuclear Products Co., 15635 Saranac Rd., Cleveland 10, Ohio.** 84J

Equipment Cost Indexes

	Dec. 1957	March 1958
Industry		
Avg. of all	229.2	231.2
Process Industries		
Cement mfg	220.7	222.9
Chemical	230.4	232.4
Clay products	214.4	216.6
Glass mfg	217.6	219.4
Paint mfg	221.6	223.8
Paper mfg	222.0	223.9
Petroleum ind	226.3	228.6
Rubber ind	229.1	231.4
Process ind. avg	227.0	228.8
Related Industries		
Elec power equip	232.9	234.2
Mining, milling	231.8	233.8
Refrigerating	258.9	261.5
Steam power	216.9	219.5

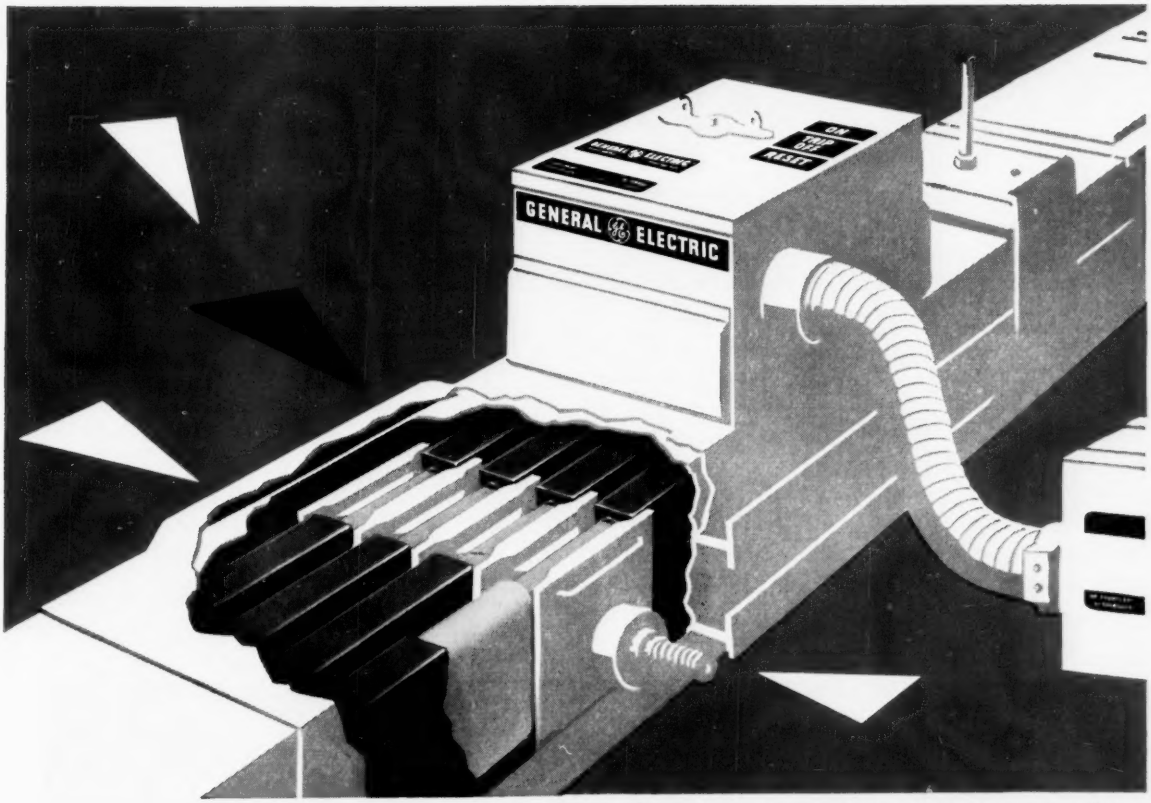
Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124–6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143–4 for annual averages since 1913.

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p. 225)



When Enjay Butyl is used as continuous insulation of tubular aluminum conductors, traveling arcs are virtually eliminated, plug outlets are essentially dead-front.

ENJAY BUTYL

helps keep costs low in new Aluminum Busway!

Enjay Butyl is extruded over the full length of the conductors used in General Electric's new Type DE Busway, the first busway designed specifically for aluminum. This new busway incorporates all 22 features that engineers consider important in busway design, yet it is up to 30% smaller and 50% lighter than other busways of comparable rating.

Enjay Butyl rubber is ideal for use as continuous insulation of tubular conductors because of its inherent resistance to ozone and to heat aging. Add Butyl's excellent electrical properties, its vulcanizability and the fact that it is the *lowest cost* rubber on the market—and you'll understand why it was chosen above all other rubbers to do this job.

Every day manufacturers are discovering new ways to use economical Butyl. Find out how Enjay Butyl rubber can cut production costs for you. For further information and expert technical assistance, contact the Enjay Company.

ENJAY BUTYL

Enjay Butyl is the greatest rubber value in the world. It's the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

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While Processors' Capital Outlays Back Down and Level Off . . .

(Million Dollars)

	1957*	1958	% Change 1957-58	1959	1960	1961	Min. — Max. 1958	Min. — Max. 1961
Chemicals	1,724	1,569	— 9	1,349	1,349	1,282	941	1,789
Pulp & paper	811	527	—35	443	474	450	285	833
Petroleum refining	853	768	—10	737	752	647	522	845
Rubber	200	172	—14	191	210	210	122	227
Stone, clay & glass	572	493	—14	426	455	471	261	586
All mfg.	13,647	11,129	—18	9,138	9,178	9,130	6,080	13,039

*U. S. Dept. of Commerce, Securities and Exchange Commission, McGraw-Hill Dept. of Economics.

. . . Research and Development Spending Rushes Ahead Undismayed . . .

(Million Dollars)

	1957	1958	1961
Chemicals	568	596	685
Pulp & paper	48	51	58
Petroleum refining	231	245	294
Rubber	76	78	93
Stone, clay & glass	64	68	83
All mfg.	6,935	7,947	9,462

. . . to a Payoff Close at Hand

% Expecting Payoff in 3 Yr.	in 5 Yr.
15	71
25	94
12	75
50	67
44	94
39	91

Chemical Spending: Firms Retrench and Wait

William H. Chartener, McGraw-Hill Dept. of Economics

Capital spending in the chemical process industries this year will fall short by 14% of 1957's record total. And present plans call for another 11% drop in 1959.

Most CPI companies, though, are counting on the current recession to be short and are waiting—waiting for some pickup in sales before the end of the year. They expect, in fact, a steep rise in their sales curves by 1961, with 1958-61 sales increases ranging from 9% in petroleum refining to 25% in chemicals and rubber (see table, p. 88).

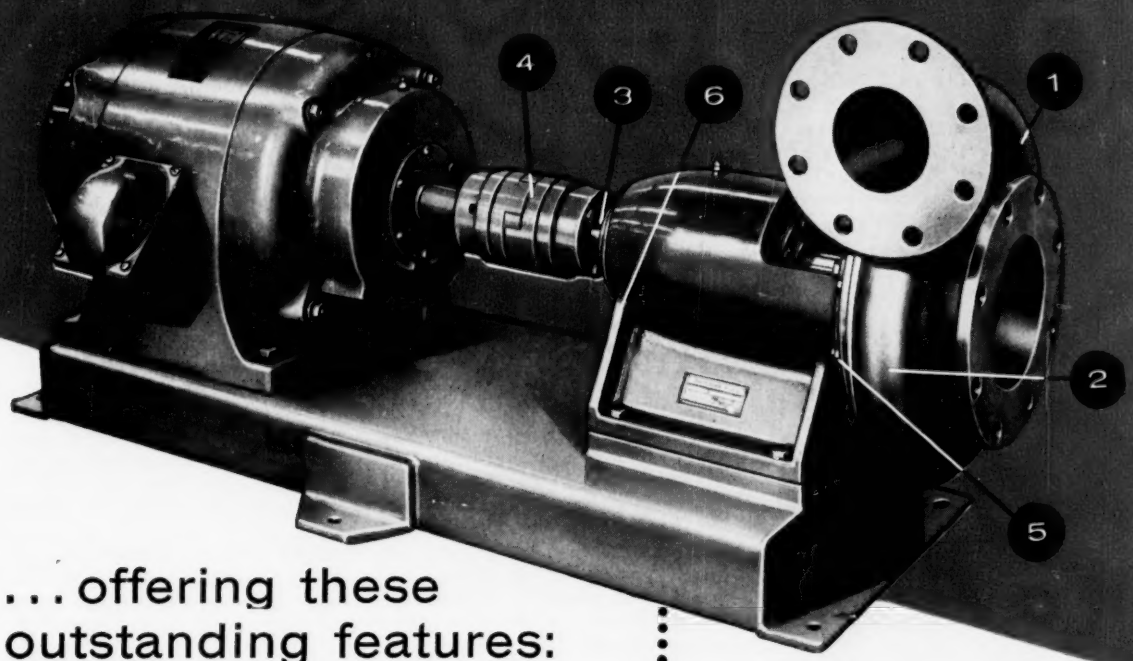
▶ **Wait for Payoff**—And they're waiting for—and expecting—their research and development programs to pay off. For R&D outlays are scheduled to keep rising at a smart pace despite this year's disappointing sales and sharp cutbacks in plant and equipment expenditures. R&D spending in the CPI this year will top 1957 by 5%; a further rise of 17% is planned by 1961.

We asked companies how soon they expected their expenditures on research and development to pay off. One-half or more of the companies in all the process industries, save rubber, said they look for research to pay off in three to five years. Half the rubber companies expect research to pay off in less than three years.

▶ **Down, Then Up**—Thus, chemical processors expect their cap-

TRI-CLOVER

presents an *ALL-NEW* series of INDUSTRIAL *Centrifugal* PUMPS for dependable corrosion-resistant service



. . . offering these outstanding features:

1. *Volute type case* . . . specially designed heavy duty pump head gives maximum conversion of velocity to pressure energy, with high efficiency. Pump head swings 360 degrees.
2. *"Francis" type impeller* . . . produces lower pressure at shaft sealing surface—minimizes danger of impeller clogging.
3. *Precision-machined shafts* . . . minimize possibility of deflection or vibration. Over-sized ball bearings insure long, trouble-free operation.
4. *Spacer type coupling* . . . allows removal of complete pump rotary assembly, including impeller and frame, without removal of base or disturbing piping or electrical connections.
5. *Exclusive backplate design* . . . accommodates either packing gland or mechanical seal stuffing boxes, which can be easily interchanged in the field.
6. *Rigid one-piece frame* . . . of cast iron, has oversized pocket for collecting any leakage from stuffing box, and can be piped to drain away from pump.

For over 35 years, Tri-Clover Division has specialized in the development and manufacture of high quality corrosion-resistant centrifugal pumps. Now, to further extend this pump line, and to meet more highly specialized pumping requirements, Tri-Clover presents an entirely new series of high efficiency centrifugal pumps.

This new series of Industrial Stainless Steel Pumps is offered in a full range of sizes and seal styles, including models to operate at temperatures of minus 80° F to plus 400° F.

SEND FOR BULLETIN

For the full story on these new pumps, write for a copy of the new Pump Bulletin 258-I.

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1958 Sales Lull Is Only Temporary

ECONOMICS . . .

	% Sales Increase 1957-58	1958-61
Chemicals	—1	25
Pulp & paper	1	19
Petroleum refining	—5	25
Rubber	1	22
Stone, clay & glass	3	9
All mfg.	**—2**	**20**

ital budgets to hit bottom next year and turn up by 1960. Under very favorable conditions, CPI capital spending in the coming four years could even top the 1957 peak figure by an average of $200 million/yr. A longer-than-expected business slump might, however, pull present spending plans down by as much as one-third.

These are some highlights from the 11th annual survey of business' plans for new plants and equipment just completed by the McGraw-Hill Dept. of Economics.

This survey is not a forecast. Rather, it is a report of actual plans of companies which account for some 40% of all manufacturing employment and are a broad sample of leading companies in non-manufacturing industries.

As for manufacturing as a whole, capital spending will be down 18% this year, and another 18% in 1959, according to present plans. As in the CPI sector, preliminary plans already call for an increase in 1960 and thus point to sometime in 1959 as the bottom of the spending slide. For all business, the expected drop is 12% this year, with another 8% in 1959.

▶**Sales, Output Lull**—Lagging sales and the widening gap between operating rates and manufacturing capacity are the main reasons behind current trimming of plant expansion. In all the process industries operating rates were well below preferred levels at end of 1957; these rates have been slipping almost steadily since late 1955.

Here are the average operating rates reported for the CPI at the end of 1957 compared to their preferred rates (in parenthesis): Chemicals, 81% (92%); petroleum refining, 90% (95%); paper and pulp, 88% (95%); rubber, 80% (90%); stone clay and glass, 74% (86%).

Average operating rate for all manufacturing at the end of 1957 was 78%, against a preferred rate of 90%. Since the turn of the year, operating rates in most industries probably have dropped a few more points.

▶**Slower Building**—In spite of swelling spare capacity, plans call for some further additions this year and in the next three years. In the chemical industry, capacity will rise by 7% this year and another 19% by the end of 1961. (This, however, represents a slower rate of growth than in the seven years from 1950 to 1957, when chemical capacity went up 76%.)

Pulp and paper and the stone, clay and glass industry expect to add new capacity at an average rate of about 3% a year in the four years 1958-61, compared with their 6% expansion last year. Petroleum refining and rubber plan capacity increases of about 2% a year, roughly the same as their 1957 gains.

In all the process industries—except the chemical industry itself—there is a shift in emphasis this year away from expansion and toward modernization and replacement. In the chemical industry, however, 72% of all capital spending will be devoted to expansion, up from 68% last year. Petroleum refining, with a slow but steady rate of growth in capacity, will put only 16% of its 1958 capital outlays into expansion.

Research and new product development are getting an increasing role in CPI plans.

This year, for the first time, the process industries as a group will spend more than $1 billion on R&D. The chemical industry, long a leader in research, will account for almost $600 million.

By 1961 chemical companies expect to be investing $685 million in R&D, while the CPI group plans to spend $1.2 billion.

▶**Aims and Rewards** — This year's McGraw-Hill survey, which provides the only current data on industry's plans for R&D expenditures, reveals some new information on the purposes and rewards of research.

On purposes of research, companies were asked whether their research was principally aimed at new products, new processes, or product improvement.

In the chemicals category 67% of the firms specified new products, 27% improved products; in petroleum refining 42% named new processes and 29% cited both new products and improved present products; in pulp and paper, it was 50% for product improvement, 37% for new products; in rubber, half the companies stressed new products, a third mentioned product improvement; in stone, clay and glass, 48% specified improved products, 42% new products.

On the rewards of research, companies were asked what percent of their 1961 sales they expected to be in products not produced in 1957.

In the chemical industry the average figure was 14%; in paper and in stone, clay and glass, 10%; in the rubber industry, 8%; and in petroleum refining, 4%. For all manufacturing the average report was that 12% of 1961 sales would be new products.

▶**Just Being Careful** — All in all, the new McGraw-Hill survey reflects a cautious—but far from panicky—attitude on the part of business toward the economic outlook. Companies in the process industries and in business in general are proceeding with expansion plans, though at a much slower rate than in the past three years. They are going ahead also with big outlays for replacement and modernization.

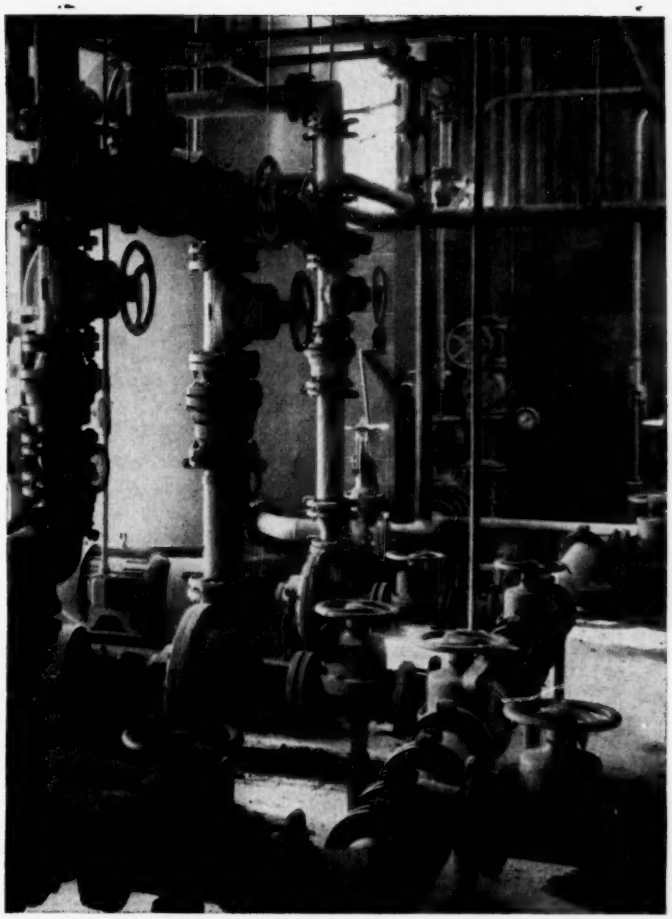
Rising sales expectations and a continued step-up in R&D outlays, however, indicate clearly that business is banking on a short recession and a resurgence of growing markets.

Freud on the Farm

One of man's claims to fame in the animal kingdom—his mixed-up psyche—won't stand up anymore. Chemical tranquilizers "help animals overcome fear, make them docile, help them adjust."

Exciting conquests for the "happy pills": Heifers that don't run from milking machines, dogs that don't bite mailmen.

Maintaining maximum flow in serum lines with minimum pressure drop



Goodyear Tire & Rubber Company reports no valve clogging or interruption to flow in handling viscous fluids — with Grinnell-Saunders Straightway Diaphragm Valves.

Grinnell-Saunders Straightway Valves are now in use on serum lines of the Goodyear Tire & Rubber Company. Serum is a suspension of rubber particles in an acid brine solution. The installation pictured above is in Goodyear's Synthetic Rubber plant at Houston, Texas.

Grinnell-Saunders Straightway Valves were selected for this service because of their straight-through design. Material in process cannot build up and choke off flow because there are no pockets or gate trenches to trap solids. The straight-through feature also assures speed, ease and economy of rodding out, when necessary. When a diaphragm must be replaced — that job, too, can be done quickly, without removing the valve body from the line.

Isolation of operating parts from the fluid stream is still another important advantage of the Grinnell valve . . . eliminating corrosion and clogging of the valve mechanism while, at the same time, preventing contamination of product in the line.

Grinnell-Saunders Diaphragm Valves are available in a wide range of body, lining, and diaphragm materials to meet different service conditions. To secure further information, contact the Grinnell branch office nearest you — or write directly to Grinnell Company, Inc., 277 West Exchange Street, Providence, R. I.

Open

Diaphragm lifts high for streamlined flow in either direction. No irregular surface to trap deposits.

Closed

Diaphragm presses tight for positive closure, even when handling viscous or fibrous materials.

GRINNELL-SAUNDERS DIAPHRAGM VALVES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

SAVE TWO WAYS WITH NEW HI-CAPACITY Fulflo Filter

Model WH Hi-Capacity Fulflo Filter with optional Cover-Lifting Device and Pressure Gauges. Note compactness and simplicity of inner assembly.

The completely new Hi-Capacity Fulflo Filter brings you substantial production savings through decreased downtime and improved quality — plus *lower-than-ever initial cost.*

This compact sturdy steel filter is available in a full range of sizes — with from 24 to 270 10-inch Honeycomb Filter Tubes — for flow rates as high as 1350 gpm or more, depending on viscosity. Brand new cover is fastened by sturdy bolts which swing down when loosened to release cover for easy access to filter tubes. Optional Cover-Lifting Device enables cover to swivel aside for even speedier servicing.

Another outstanding advantage — all standard models are designed for *operating pressures up to 150 psi.* Higher pressure models are engineered to order.

The new Model WH Fulflo Filter provides continuous micro-clarity, at minimum pressure drop, for all types of liquids and gases. Exclusive Honeycomb Filter Tubes provide true *depth* filtration through hundreds of filtering tunnels, precision engineered for uniformity of size, shape and depth. Tubes are available in a wide range of positively controlled densities and in a variety of natural and synthetic fibres.

Fulflo Filters are engineered to your exact requirements. For folder on the new Model WH, write to Department CE.

COMMERCIAL FILTERS CORPORATION
MELROSE 76, MASSACHUSETTS
PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

MICRO-CLARITY AT MINIMUM COST

Fulflo FILTERS — *with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.*

CFC FILTERS — *Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.*

BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

CONDENSER AND HEAT EXCHANGER TUBE EDITION

Advantages of Duplex Tube

by C. L. BULOW
Chief Corrosion Metallurgist
Bridgeport Brass Company

Bridgeport Duplex Tubes are used where a heat exchanger tube is attacked simultaneously inside and out by different types of corrosive media. Duplex is made by drawing two tubes of different metals, one over the other, and combining them into a single tube.

Metal Combinations

This type of construction permits the use of a wide range of combinations of metals—Admiralty, Cupro Nickel, Copper, Aluminum Brass, and many others coupled with steel, nickel, aluminum, stainless steel, Monel, etc.

Many Uses

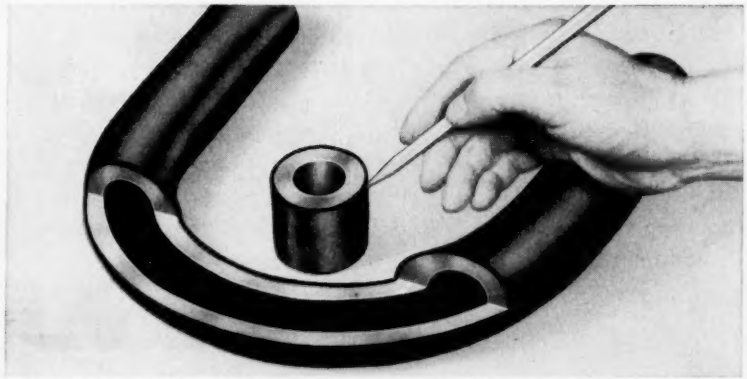
Applications for Bridgeport Duplex Tubes include successful service in the production of ammonia, benzol, hydrocarbons, resins, rubber chemicals, carbon dioxide and many other chemicals. Likewise, duplex tubes are admirably suited for replacement of ordinary boiler tubes for use in air-compressor aftercoolers, lube-oil coolers and fuel-oil heaters.

Applying Duplex Tubes

It is virtually impossible to prescribe what duplex tube combination is best for any specific use without information on the specific requirements of the application. The important point to remember is that with duplex tubes you can practically "tailor" the tube to your requirements.

Laminated Tube Sheets—Another Weapon In The Fight Against Dual Corrosion

Bridgeport now offers metallurgically bonded dual-metal tube sheets especially designed to combat dual corrosion. These tube sheets are a valuable adjunct to duplex and copper and copper-alloy condenser and heat exchanger tubes. They are available in a number of combinations such as Naval Brass, Muntz Metal, silicon bronze, copper, and Monel with steel and stainless steel.



Heavy-wall duplex consists of a thin wall of copper or other nonferrous metal around a thick-walled steel tube—a perfect combination for high pressures and utmost corrosion resistance.

New Bridgeport Heavy-Wall Duplex Tubes Lick Dual Corrosion Problems at High Pressures

High-pressure heat exchanger operation presents two very basic problems. The first is to find a tube thick enough to stand up under the pressures used. The second is to find a tube material able to withstand corrosive attack for long periods of time and at the same time provide desired heat-transfer characteristics.

New Heavy-Wall Duplex

Bridgeport came up with the answer in a new design—heavy-wall duplex tube. Heavy-wall duplex consists of a heavy inner tube with an outside covering of thin-wall nonferrous tubing. Although the inner tube is low carbon or stainless steel, and the outer tube Cupro Nickel, Red Brass, Admiralty or copper, both inner and outer tube materials can be varied to suit the conditions of the application.

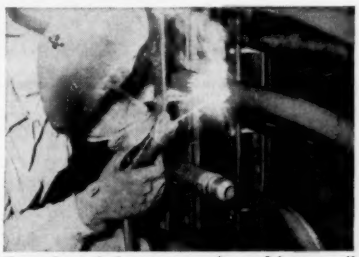
Advantages

Use of a nonferrous outer tube cuts corrosive effects of cooling water. And, because it resists corrosion, it gives the entire tube installation superior heat-transfer characteristics. With proper cleaning and maintenance, a Bridgeport Heavy-Wall Duplex Tube will substantially outperform single metal tubes.

Installation

Most applications are in cascade coolers where bent tube ends are required. Small sections of heavy-wall duplex can be formed to the desired radius or one end of long sections can be bent, thereby eliminating one weld joint.

Heavy-wall duplex tubes are designed to the ASME Code to operate at pressures up to 5,000 psi. They will, however, pass hydrostatic tests at much higher pressures. In actual operation they will give years of satisfactory trouble-free service with no more than normal cleaning and maintenance procedures.



To make hairpin turns, sections of heavy-wall duplex are bent and welded to straight lengths or other bent sections.

Further Information

More detailed information on sizes, characteristics and ratings of Bridgeport Heavy-Wall Duplex Tubes will be furnished on request. Our Technical Service representatives are also available to cooperate with you in working out application problems. For prompt service, call your nearest Bridgeport Sales Office.

Bridgeport

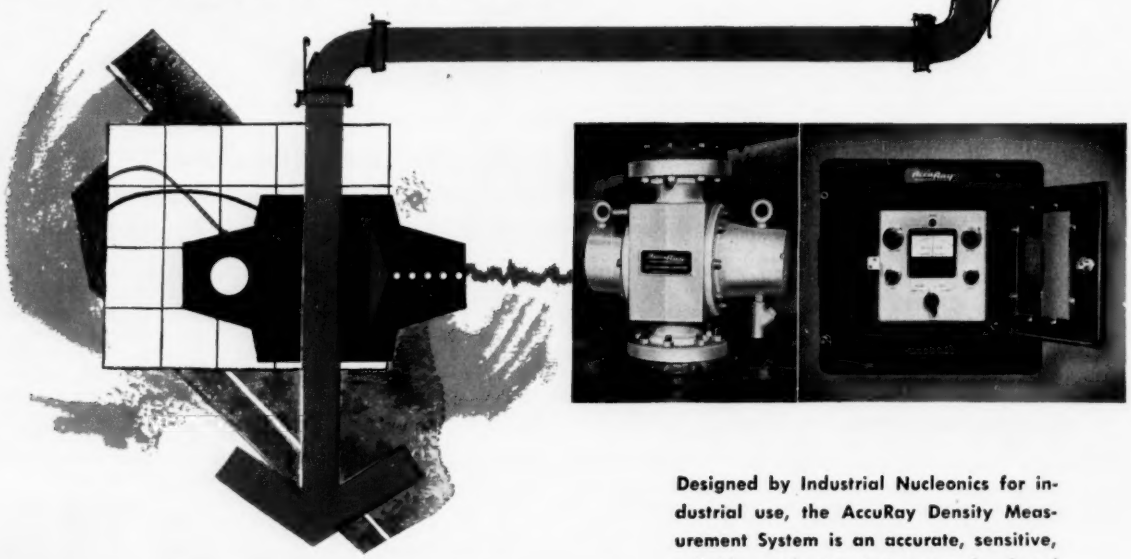
BRIDGEPORT BRASS

Bridgeport Brass Company, Bridgeport 2, Connecticut • Offices in Principal Cities
In Canada: Noranda Copper and Brass Limited, Montreal

cut production costs with *AccuRay*®

density measuring systems

Knowledge of specific gravity or percent of solids in feed and output streams is essential in determining process efficiencies. Only with accurate, continuous measurement can operating data be accumulated to learn where economies can be effected. AccuRay Density Systems provide this information to permit analysis of existing variations. With this data, product characteristics which limit throughput rate and yield may be identified. Production costs are lowered by, (1) conserving raw materials, (2) reducing recycling and, (3) decreasing fuel costs.



More than 60% of the nation's tin cans are made from steel controlled with AccuRay Systems

67% of the tires manufactured in the United States are built of fabric controlled with AccuRay Systems

8 of the 10 largest paper manufacturers use AccuRay Measurement Control Systems to maintain uniform basis weight

Designed by Industrial Nucleonics for industrial use, the AccuRay Density Measurement System is an accurate, sensitive, reliable production instrument developed specifically for rigorous conditions encountered in process industries. AccuRay Continuous Flow Measurement Systems are widely used in the steel, rubber, paper, tobacco, plastic and laminating industries.

Please send Bulletin NI-158 for complete details on AccuRay Continuous Flow Density Systems

Name ..... Title .....

Company .....

Street .....

City ..... Zone ..... State .....

Application .....

Industrial Nucleonics
CORPORATION
1149 Chesapeake Ave. • Columbus 12, Ohio

The WORLD'S LARGEST Manufacturer of Nucleonic Industrial Process Control Systems

One of the Largest Bethlehem-Built Converters

This forged-steel converter is a real heavyweight, one of the biggest to emerge from the Bethlehem shops. It weighs approximately 150 tons; its inside body diameter is close to 4 ft. Those thick seamless walls are designed to withstand high pressures, and Bethlehem's forging process insures the necessary ruggedness and strength.

Vessels like this are a bit unusual, of course. But for customers who need them, we're always ready with the necessary steel-making, forging, treating, and machining facilities. Thorough integration also makes possible a complete line of smaller vessels. (We remember one that weighed only 900 lb!) No matter what your requirements in size or design, we can meet the specifications in full.

Let Bethlehem help you plan new autoclaves, reactors, converters, separators, filters, accumulators. Once the design is approved, our shops will follow through with a first-class production job.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

SPROUT-WALDRON Pointers

for Mixing and Blending • Size Reduction
Size Classification • Bulk Materials Handling • Pelleting and Densifying

Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

FLOUR FLOWS LIKE WATER

When the Wonder Bread Division of Continental Baking Company went to pneumatic bulk handling just about a year ago it was the first operation of its kind in the West. Although many similar systems have been put in operation since, the Wonder Bread story is well worth repeating.

Storage capacity, equal to over 10 carloads of flour, is held in three 14′ diameter vertical Permaglas bins. Airslide cars, unloaded by S-W Portaflow Units, blow the flour through 4″ conveying lines right to the top of the 50 foot high bins.

"The flour flows like water" is the most common expression you'll hear around this plant. Although our engineering division tells us that true fluidization in any pneumatic system is only possible for short distances, when you see flour being unloaded and binned at the rate of 1000 lbs/minute, you feel like saying that if this flour isn't flowing like water, it sure is mighty close! Reprints of the article describing the system at Wonder Bread are available on request. Our files contain many case history articles, catalog and technical reports. For prompt analysis of your materials' handling problem, contact your Sprout-Waldron representative.

LABORATORY PELLET MILL USED IN RESEARCH

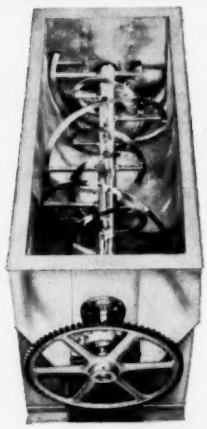
The Sprout-Waldron Laboratory Pellet Mill exactly reproduces the end results to be anticipated from high production pelleting machines. This enables researchers to complete studies on many applications involving pelleting and to project operating methods and costs.

The Sprout-Waldron Laboratory Mill is not a miniature pelleter, hence there are no complicated factors needed for scale up. Production rates are directly proportional to the horsepower utilized. Here is a piece of lab equipment which has every advantage found on production models. A large variety of die sizes is available from stock and the machine can be fed by hand or by any number of mechanical feeding devices. For details, ask for Bulletin 176.

— SW —

THE BIG PLUS

Copies of the S-W condensed catalog (Bulletin No. 178) of equipment and systems for the chemical and processing industries are still available. This two color, 20 page booklet illustrates attrition, hammer, roller and pellet mills; vertical, horizontal and continuous mixers; sifters, crushers, blenders, bucket elevators, conveyors, feeders and the complete line of pneumatic handling equipment, bulk trucks and storage structures.



TROUBLED WITH A "DIRTY" MIXER?

Pigment and dye manufacturers know the danger of color contamination. That's why so many of them specify the Sprout-Waldron mixer with its smooth crevice-free stainless steel interior.

Take a good look at the unretouched interior above. Notice the smooth surface, the large radius welds, the absence of bolts and the many signs of Sprout-Waldron craftsmanship which assure you of a mixer that is easy to clean, and designed to produce perfect batches day in and day out.

This small Laboratory Mixer is suitable for production work. Its features include: variable speed drive, stainless steel construction throughout, jacket for heating or cooling, thermometer well and flush type, liquid-tight plug gate. From the smallest Lab Mixer to the largest conceivable production model, you can rely on Sprout-Waldron know-how to keep your products free from contamination. Ask for Bulletins 194, 128 and 148.

CP/103

your Aloyco sales engineer has only one business...

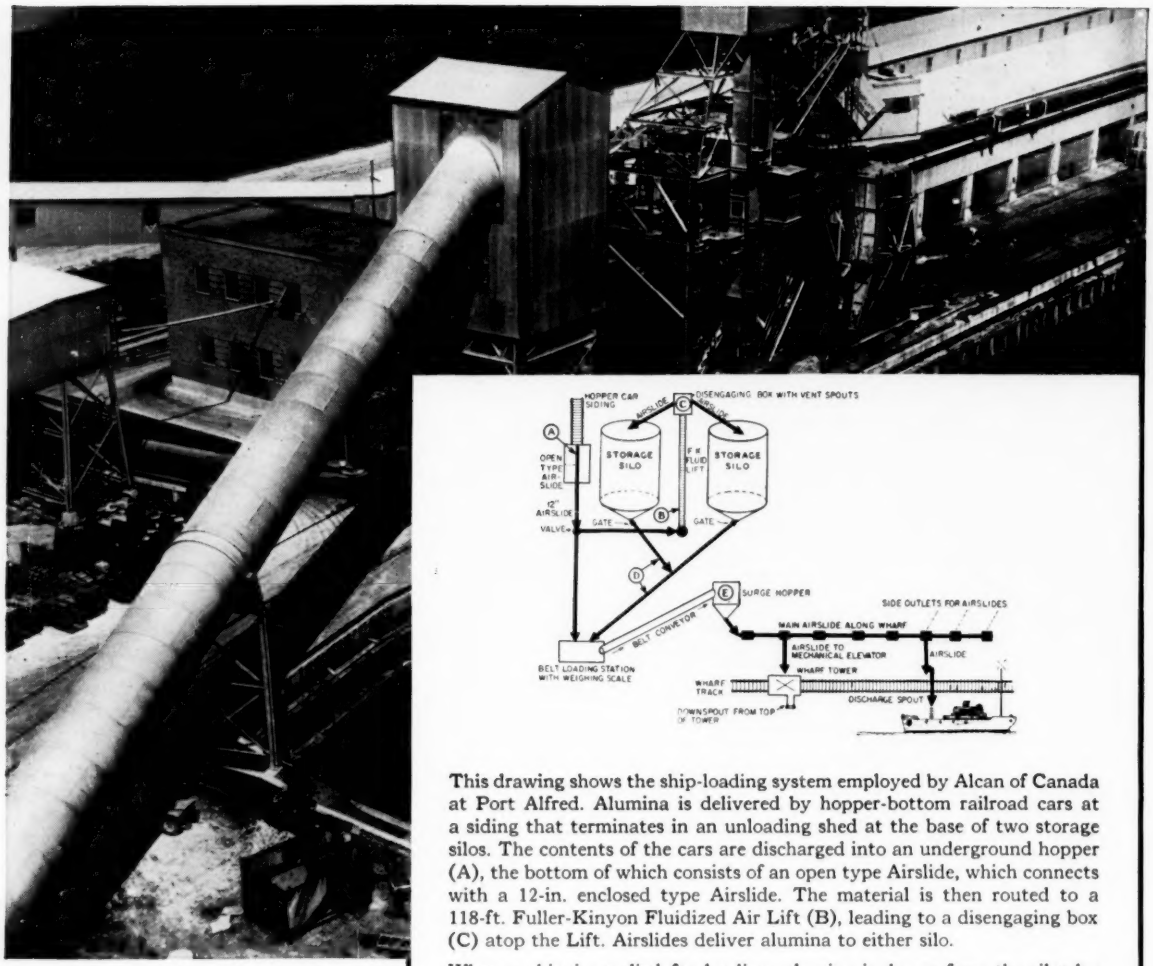
stainless steel valves

Your Aloyco sales engineer is a specialist... he handles only one line. You, as an Aloyco customer, deal directly with a man who knows his product and its application. He is equipped to get close to your problems and you'll find that this closeness to our customers goes right back to the Aloyco Plants. Doesn't it make sense to depend on the man and the company that specialize in corrosion resistant valves exclusively?

ALOYCO 503 Globe Valve... retained bonnet gasket... bolted bonnet... OS&Y... renewable Teflon disc fully retained. The Aloyco Valve line includes a wide range of alloys, types, sizes, and pressures of 150 lb, 300 lb, 600 lb and above. Nuclear Valves up to 2,500 lb.

ALLOY STEEL PRODUCTS COMPANY
Linden, New Jersey

Longer Lasting
ALOYCO
VALVES
1ST IN CORROSIVE SERVICE



This drawing shows the ship-loading system employed by Alcan of Canada at Port Alfred. Alumina is delivered by hopper-bottom railroad cars at a siding that terminates in an unloading shed at the base of two storage silos. The contents of the cars are discharged into an underground hopper (A), the bottom of which consists of an open type Airslide, which connects with a 12-in. enclosed type Airslide. The material is then routed to a 118-ft. Fuller-Kinyon Fluidized Air Lift (B), leading to a disengaging box (C) atop the Lift. Airslides deliver alumina to either silo.

When a ship is readied for loading, alumina is drawn from the silos by open type Airslides and transported by means of 16-inch Airslides (D) to a belt, which delivers to a surge hopper (E) feeding the 400-ft. long Airslide for conveying to the ship. Air for the operation of the Fuller-Kinyon Fluid Lift is supplied by a Fuller Rotary Compressor.

Here's how ALCAN reduces ship loading time 50%

. . . FULLER SYSTEM PAID FOR ITSELF IN WEEKS

Expansion of The Aluminum Company of Canada's pneumatic conveying system at Port Alfred, Quebec, has cut ship loading time of alumina by 50 percent.

Engineered and built by Fuller, this pneumatic conveying system has eliminated frequent interruptions in the loading schedule and made possible big savings in handling cost. The initial cost of the installation was absorbed within the first few weeks of operation!

Additional equipment consists of two 35-ft. portable F-H Airslides® operating in tandem off of a main 19-in. Airslide running a distance of 400 feet along the roof of the wharf.

These Airslides discharge the alumina directly into the hold of the ship, eliminating the time-consuming shutdown during relocation of the bucket elevator and tower for delivery to various holds.

This carefully planned system points out how Fuller's more than 30 years of specialized experience in engineering and manufacturing pneumatic materials-handling equipment helped another company save time and money. We would like to put our facilities to work for you, too. Write, giving us details of your operations.

SEE CHEMICAL ENGINEERING CATALOG
FOR DETAILS AND SPECIFICATIONS

G-167
4365

FULLER COMPANY

134 Bridge St., Catasauqua, Pa.

SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION

Birmingham • Chicago • Kansas City • Los Angeles • San Francisco • Seattle

FULLER COMPANY GENERAL AMERICAN TRADE MARK

Fuller

. . . pioneers in harnessing AIR

completely corrosion-proof

- **Chemically inert from end to end** — non-contaminating and universally useful
- **Flanged ends** — liner covers full gasket face for continuous protection
- **Unaffected by corrosive fluids** — special compound of Teflon developed for maximum life

Here's a hose exclusive on two counts. (1) It has *flanged ends* – the first fluorocarbon hose to have them. (2) It has the patented Fluoroflex®-T tube.

Tube extends to cover the full gasket face of the flange, forming a continuous and integral assembly of hose and flanges. Fluid cannot contact metal. Eliminates need for costly alloy fittings.

Cleaning problems are simplified, too. The smooth, continuous bore prevents entrapment of materials.

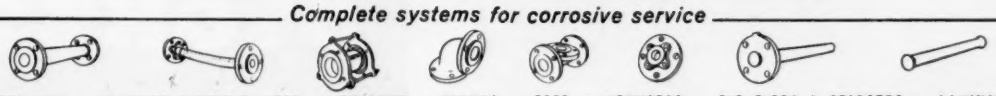
A special, high-density, non-porous compound of virgin Teflon, Fluoroflex-T is completely inert to virtually all known chemical and corrosive solutions, solvents and gases to 500° F. Write for data.

RESISTOFLEX CORPORATION, Roseland, N.J. Other Plants: Burbank, Calif.; Dallas, Tex.

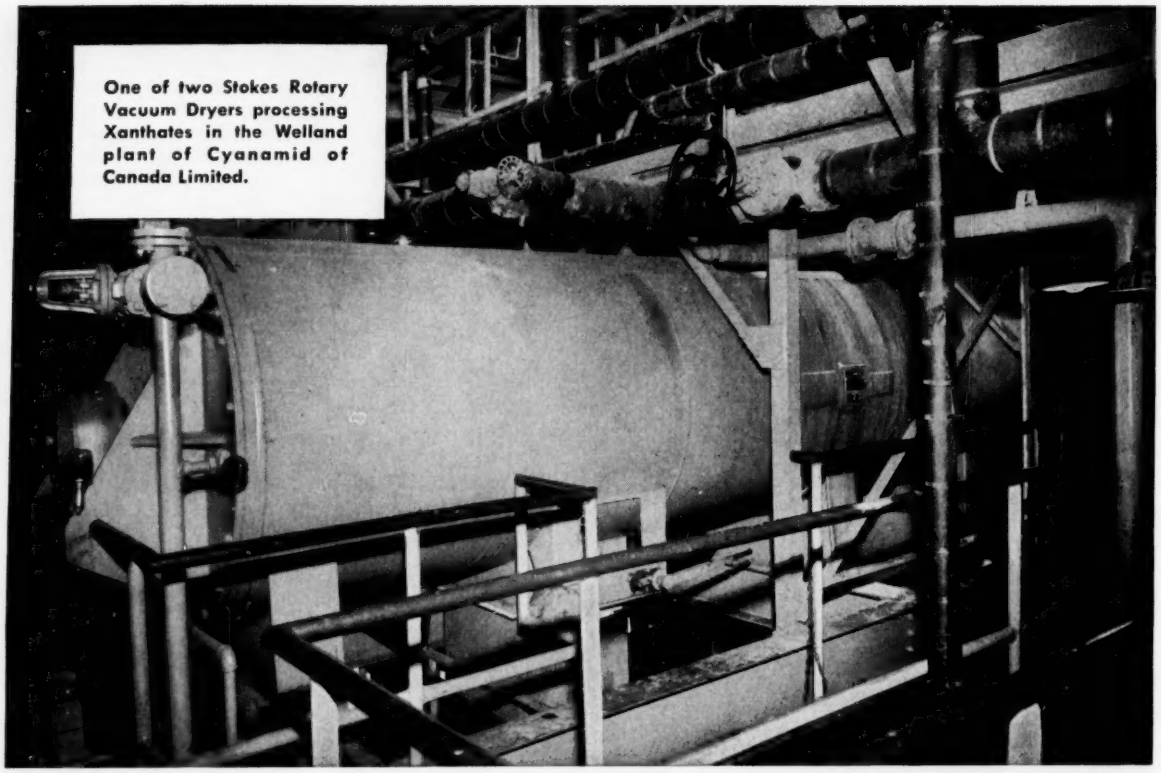
® Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.
® Teflon is DuPont's trademark for TFE fluorocarbon resins

RESISTOFLEX

Complete systems for corrosive service



LINED STEEL PIPE • FLANGED FLEXIBLE HOSE • BELLOWS • ELBOWS • TEES • REDUCERS • DIP PIPES & SPARGERS • LAMINATED PIPE



One of two Stokes Rotary Vacuum Dryers processing Xanthates in the Welland plant of Cyanamid of Canada Limited.

Stokes Rotary Vacuum Dryers process Xanthates for Cyanamid of Canada Limited

The Welland plant of Cyanamid of Canada Limited, near Niagara Falls, Ont., is the only Canadian producer of Xanthates . . . a series of materials used in mining and mineral industries as flotation reagents. Stokes Rotary Vacuum Dryers play an important part in the production of these heat and air sensitive materials.

The standard "extra" features of these dryers give continuous operation that means no maintenance shutdowns—process uniformity that means more pounds of saleable products—and operating efficiency that means more profit.

- Continuous double-spiral agitators . . . fast, uniform drying . . . easy unloading . . . low power requirements.
- Heated agitator shaft and arms . . . up to 25% greater heat transfer.
- Self-aligning, tapered roller bearings . . . low power requirements . . . less stuffing box wear.
- Plug-type, flush discharge door . . . no undried pockets . . . rapid unloading.
- Process-proved options, selected according to your product requirements . . . spring loaded scrapers . . . heated or unheated, conventional or inverted dust filters . . . special construction materials . . . fixed or variable speed drums.

Stokes produces rotary vacuum dryers, rotating vacuum dryers, vacuum shelf dryers, drum dryers and flakers, tabletting equipment . . . maintains a complete laboratory to provide expert application assistance. Write Stokes, or contact your nearest Stokes office for complete information.

Vacuum Equipment Division
F. J. STOKES CORPORATION
5500 Tabor Road, Philadelphia 20, Pa.

STOKES

You Can Pump in controlled volume

HYDROCHLORIC ACID... all concentrations

CHLORINATED HYDROCARBONS

CORROSIVE METALLIC SALT SOLUTIONS

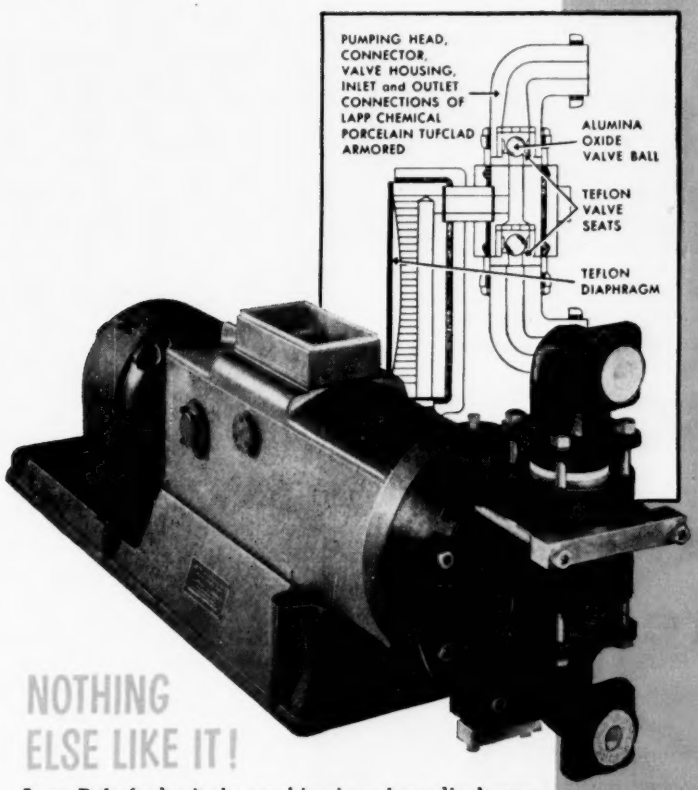
DILUTE ACIDS

MIXED ACIDS

WITH

Lapp PULSAFEEDER

COMPLETELY NON-METALLIC CONSTRUCTION AND NO STUFFING BOX TO LEAK


PUMPING HEAD, CONNECTOR, VALVE HOUSING, INLET and OUTLET CONNECTIONS OF LAPP CHEMICAL PORCELAIN TUFCLAD ARMORED
ALUMINA OXIDE VALVE BALL
TEFLON VALVE SEATS
TEFLON DIAPHRAGM

Solid Lapp Chemical Porcelain, combined with parts of alumina ceramic and Teflon plastic, is used for the liquid end of this model of Lapp Pulsafeeder. All parts which can come in contact with liquid being pumped are non-metallic, chemically inert. Thus, positive-displacement metered pumping of "hard-to-handle" corrosive chemicals is made certain and permanently trouble-free.

WRITE FOR BULLETIN 440

with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division, 3600 Poplar St., Le Roy, N. Y.

Lapp

NOTHING ELSE LIKE IT!

Lapp Pulsafeeder is the combination piston-diaphragm pump for controlled-volume pumping of fluids. Reciprocating piston action provides positive displacement. But the piston pumps only an hydraulic medium, working against a diaphragm. A floating, balanced partition, the diaphragm isolates chemical being pumped from working pump parts—eliminates need for stuffing box or running seal. Pumping speed is constant; variable flow results from variation in piston-stroke length—controlled by manual hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

Thousands of pressure vessels like these have been produced for the A.E.C. by Newport News, ahead of contract delivery schedule. Nickel-plated inside and out, they withstand corrosive uranium-hexafluoride gas.

When the pressure's on for pressure vessels

Specialized production techniques and the skill of Newport News craftsmen operating vast fabricating shops team up to deliver trainloads of pressure vessels on schedule.

When it comes to turning out process equipment, Newport News has the facilities and experience. So get a bid from Newport News on your present or future projects. Get the benefit of plant methods developed by specialists producing pressure vessels, vacuum tanks, towers, reactors, weldments and sub-assemblies.

Look over the scores of ways in which Newport News can help you . . . send for the easy-to-read, illustrated booklet *Facilities and Products.* It's yours for the asking.

Engineers: Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News
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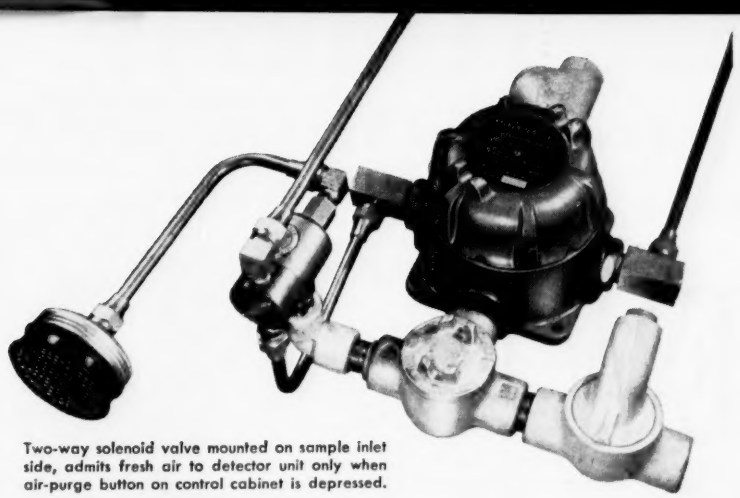
Newport News, Virginia



Two-way solenoid valve mounted on sample inlet side, admits fresh air to detector unit only when air-purge button on control cabinet is depressed.

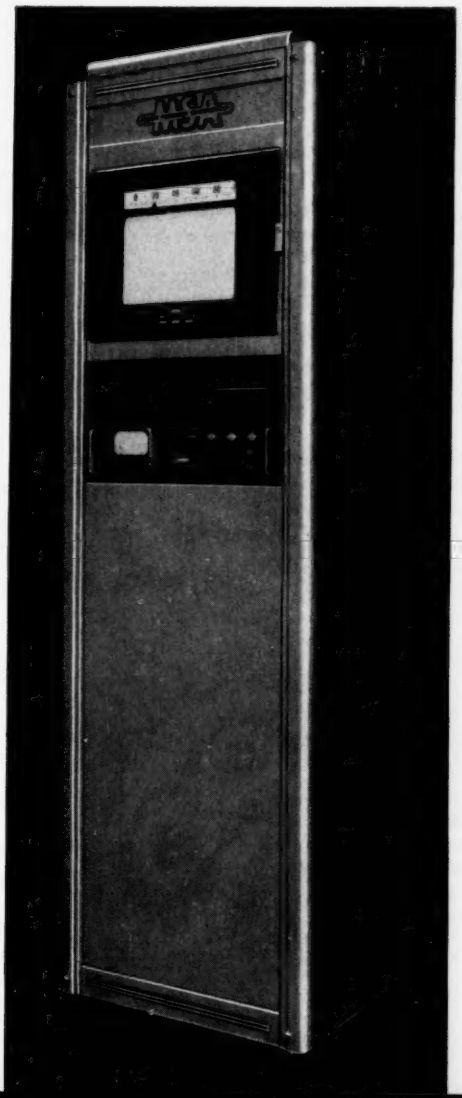
USING HIGH FLASH POINT SOLVENTS?

M-S-A® Remote Head Analyzers sample combustible vapors in elevated temperature areas such as coating ovens and drying ovens. And they do it reliably, accurately, and safely.

Combustible vapors in high temperature operations are often impossible to analyze at normal room temperature. The problem is: how to measure the sample without cooling and condensing the combustible vapors.

The M-S-A Remote Head solves this problem. Filament units are enclosed in an explosion-proof housing suitable for installation in Class 1, Group D hazardous areas. This unit may be placed in the oven or a high temperature area. This permits analysis at process temperatures without condensation of the vapors to be measured. Then, after passing through the filament chamber, the sample is allowed to cool and any condensate is trapped and disposed of, to prevent blockage of the vacuum line to the sample pump.

Where temperatures fluctuate—over a wide range in certain types of ovens—it is necessary to maintain a reasonably constant sample temperature during analysis. For this purpose, the Remote Head can be supplied with built-in, thermostatically controlled heaters to maintain a constant operating temperature within the Remote Head Assembly. This assures utmost reliability and accuracy under these sampling conditions.



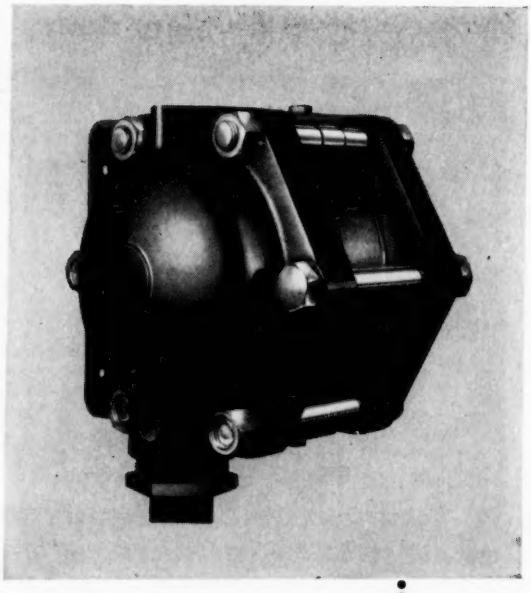
An MSA Instrument Specialist would be happy to answer your specific questions on gas analysis equipment. Get in touch with him, soon. And write us for helpful new literature on the *M-S-A Remote Head Analyzer*.

INSTRUMENT DIVISION

Mine Safety Appliances Company

Pittsburgh 8, Pennsylvania

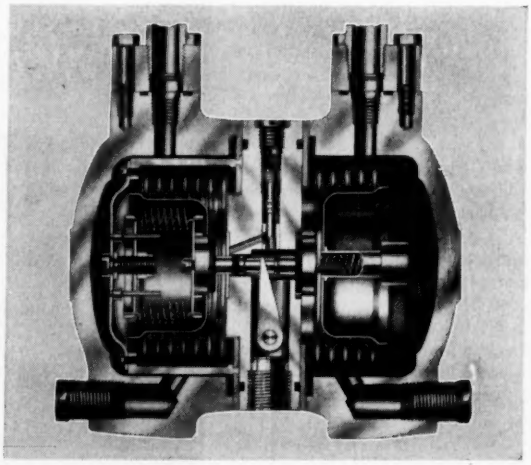
NEW!



Honeywell Bellows Meter...

unequalled for accuracy, stability, versatility in flow and liquid level metering

The new Honeywell Bellows Flow Meter gives the better performance demanded by its potential users. It's the most advanced meter body available today, with important advantages never before found in flow and liquid level meters.



Some of its outstanding features:

Sensitive and accurate—Sensitive to within 0.05% of full scale ... calibrated accuracy ±0.5% of full scale.

Leakproof—Between liquid fill and process fluid.

Automatically stabilized—Changes in meter body temperature or static pressure have no effect on output shaft position. The Honeywell Bellows Meter operates efficiently in surrounding temperatures of minus 40°F to plus 250°F.

Unmatched convenience features—Including fast range changing in the field ... connections for both horizontal and vertical piping ... quick calibration and adjustment ... easy cleaning and servicing.

High corrosion resistance—Seamless, stainless steel formed bellows give long, trouble-free service with virtually all process fluids.

Fast, effective damping adjustment—New type pulsation check with rectangular orifice enables essentially linear damping adjustment ... and you can adjust from outside the meter body during operation.

Models are available in many ranges, for both flow and liquid level measurement and control. Get details on *all* the features of the new Honeywell Bellows Meter by calling your nearby Honeywell field engineer today ... he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

REFERENCE DATA: Catalog C22-1

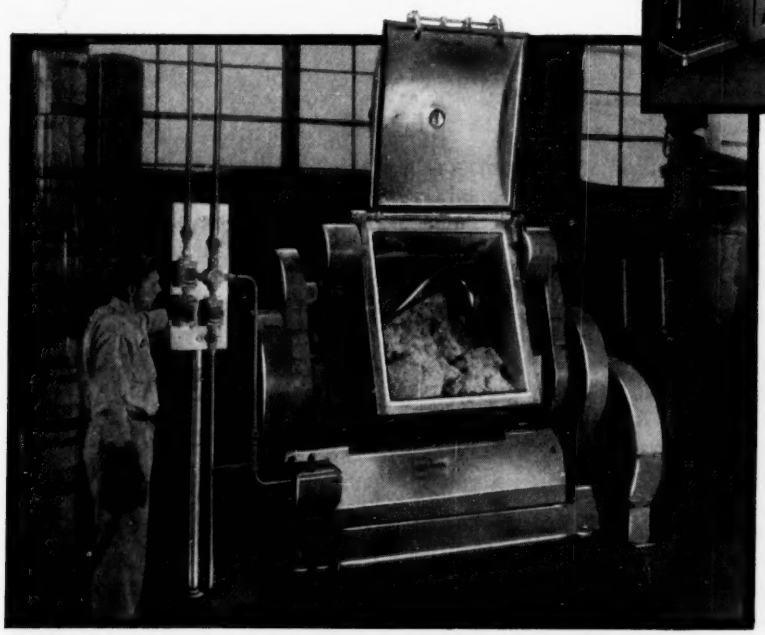
Honeywell

H HONEYWELL *First in Controls*

BAKER PERKINS MIXERS duplicate laboratory results on a production scale at WILLIAMSON ADHESIVES, INC.

Williamson Adhesives, Inc., of Skokie, Ill., are engaged in custom compounding of a wide variety of pre-mix molding materials for sale to the compression molding industry. To insure duplication of pilot results, Williamson uses Baker Perkins Mixers in both laboratory and production operations. A small 2.25 gallon Baker Perkins batch mixer is used in the laboratory for making test runs and developing new products, while a 100 gallon B-P mixer is used for actual production. As the small unit is identical in design and function to the large mixer, Williamson chemists can follow their manufacturing processes from the pilot plant stage to full scale production and maintain the same standard of quality.

The versatile B-P 100 gallon mixer can handle 500 pound loads of widely dissimilar materials; soft doughs, plastics, heavy viscous semi-liquids or dense, fibrous masses.
With the aid of careful temperature, moisture and operational controls possible with Baker Perkins equipment, Williamson is able to increase capacity, control quality and extend the range of materials which may be processed. The benefits gained with B-P Mixers at Williamson Adhesives, Inc., are proof that BAKER PERKINS Mixers are best. If you have a mixing problem, a Baker Perkins Sales Engineer is a good man to call in.



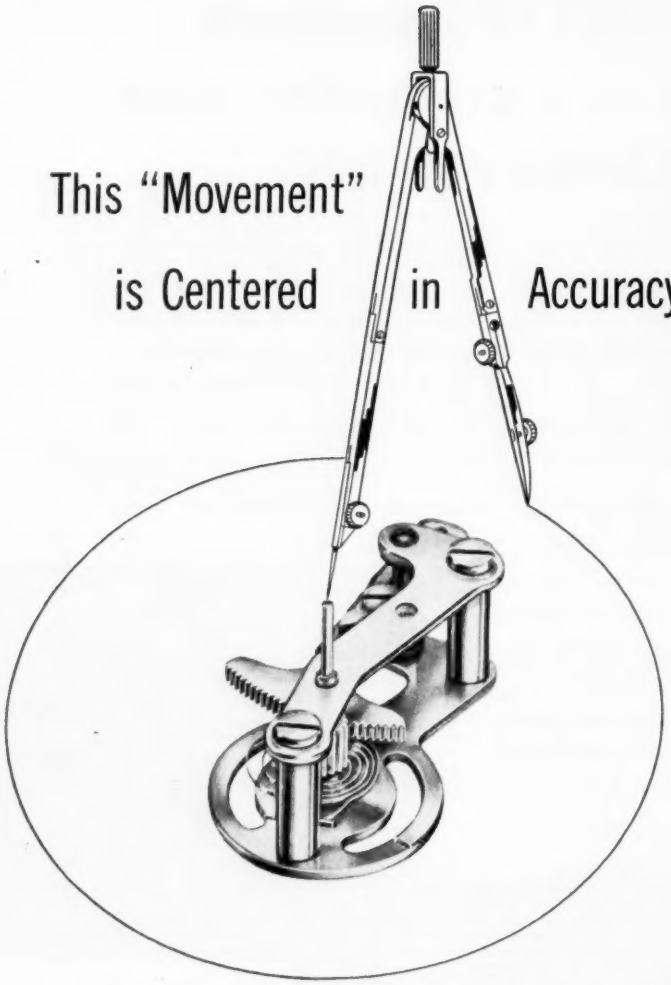
See our insert in Chemical Engineering Catalog for additional information.

360

BAKER PERKINS INC.

CHEMICAL MACHINERY DIVISION • SAGINAW, MICHIGAN

This "Movement" is Centered in Accuracy



The rotary movement in Ashcroft Duragauges has a geared center shaft on which the pointer is mounted. When pressure flexes the Bourdon tube, the pointer is always positively positioned. You can rely on the Duragauge for precise accuracy in measuring pressure no matter how severe the conditions of service.

Correct calibration is guaranteed: the one-piece link between movement and Bourdon tube prevents slippage or parting under tension. Recalibration is easy from front or rear. Universal adjustability permits uniformly graduated dials.

You can order Ashcroft Duragauges with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A complete choice of Bourdon tube materials, pressure ranges, dial sizes and case designs and materials is available. Your industrial supply distributor will gladly help you select the best combination for your requirements. So, be certain of highest sustained accuracy, durability and economy – specify Ashcroft Duragauges.

Ashcroft Duragauge in Alumalife® case—a lifetime case made of special aluminum alloy.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

G1-58

ASHCROFT PRESSURE GAUGES

A product of

MANNING, MAXWELL & MOORE, INC.

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WHAT'S YOUR PROBLEM AND HOW CAN CO_2 HELP YOU?

WRITE FOR FREE BOOKLET "APPLICATIONS UNLIMITED"

PULVERIZING OF MATERIALS WITH LOW MELTING POINT
Many products tend to melt under the heat generated by the grinding process. DDT, which is wax-like in its solid state, is an example. In such cases the product is mixed with dry ice which effectively inhibits undesirable melting and greatly simplifies pulverization. CO_2 in its gaseous state is also used to form an atmospheric "blanket" to prevent fire during the grinding of flammable materials. An example of this application is the grinding of phosphorus pentasulphide.
WATER TREATMENT
In the lime-soda ash process of water treatment, it is the custom to "sweeten" water to assure maximum softening. This "over-treating" causes plugging of water lines due to precipitation of the excess lime. In order to remove the caustic alkalinity, recarbonation is necessary. Recarbonation of the treated water with CO_2 changes the excess lime to a more soluble form and water pipes stay free-flowing longer.
FREEZE-DRYING
Freeze-drying is used to dehydrate heat sensitive substances at low temperatures. In the processing of blood plasma and the manufacture of penicillin, streptomycin and other pharmaceuticals, dry ice or liquid CO_2 is used to freeze the item being dried. Also, during the drying stage, dry ice is used to condense the moisture as it is sublimed under vacuum. Capable of quickly attaining and maintaining the extreme low temperatures required, CO_2 has the added advantage of requiring only a small capital outlay.

Liquid's new booklet "Applications Unlimited" gives you a brief introduction to 37 ways in which CO_2 is being used in modern industry. To find out how CO_2 can help your business, write for further information. Our technical staff is always ready to work with you. *Write today!*

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FIND OUT WHAT CO_2 CAN DO FOR YOU

For the free booklet "Applications Unlimited," just fill out this coupon and mail it. A list of the applications covered is at the left.

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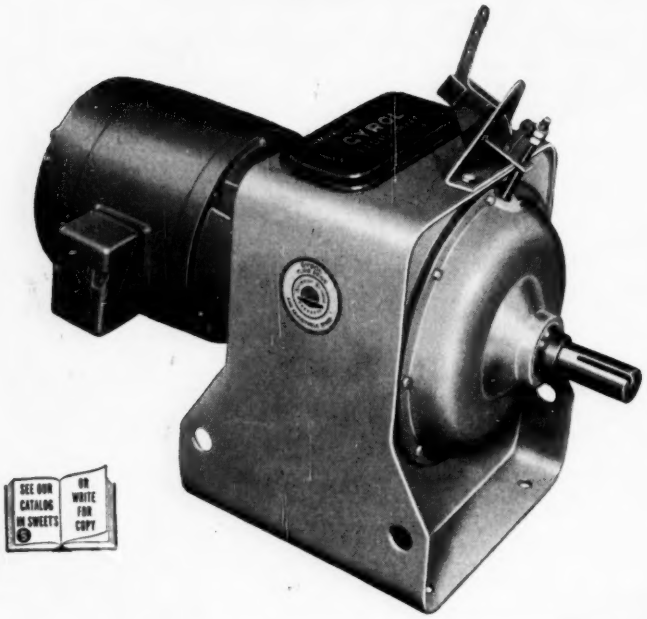
American Blower *Gýrol*® Fluid Drive varies speed steplessly without costly maintenance



Feature for feature, American Blower Gýrol Fluid Drive is your most economical solution to many industrial-drive problems. Here's why:

- **Stepless speed control**—simple, wear-free speed controller; manual or automatic operation.
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Compact and self-contained, Type VS, Class 2 Gýrol Fluid Drives come in a complete range of sizes from 1 to 800 hp. Other designs handle up to 12,000 hp. Get full information today from one of our 73 branch offices! Or write: American-Standard*, American Blower Division, Detroit 32, Mich. In Canada: Canadian Sirocco products, Windsor, Ont.

COMPARE . . . THEN SPECIFY *GÝROL*® FLUID DRIVE!

Feature	Shock Protection	Maintenance Record	Accuracy	Service Limit	Horsepower Rating
GÝROL FLUID DRIVE Type VS, Class 2	Vortex of oil isolates shock.	Good—few wearing parts; extra-long service life.	Simple, wear-free speed control.	Unlimited—all Gýrol Fluid Drive ratings are for continuous service.	Units available up to 800 hp.
FRICTION-TYPE DRIVE	Mechanical connection transmits shock.	Poor—multiple wearing parts; power transmitted by friction.	Wear and tension affect control.	Limited—service factors influence selections.	Units available up to 100 hp.

* American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

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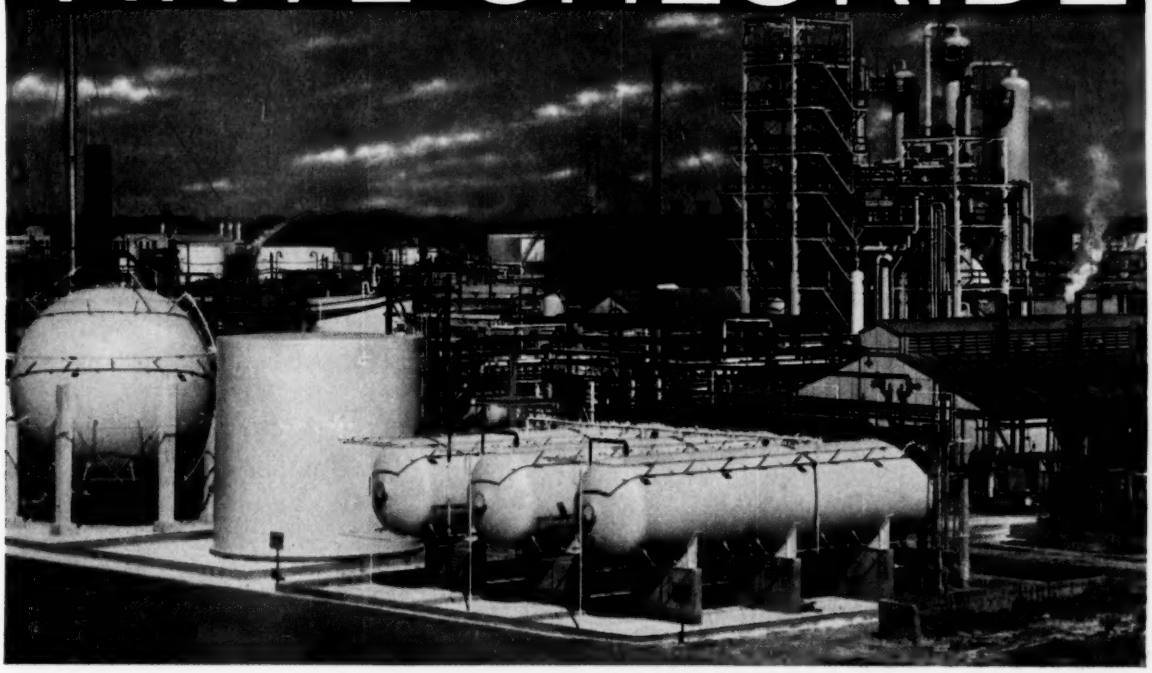
Ethyl Corporation

VINYL CHLORIDE



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Ethyl Corporation selected CATALYTIC for the engineering, procurement, and construction of its new Vinyl Chloride Plant. Close cooperation and coordination between Ethyl and CATALYTIC, utilizing to the fullest their joint experience with chlorinated hydrocarbons, resulted in successful on-stream operation of this plant within the scheduled completion time and budget.

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Describing the cause, effect, and cure of radial thrust forces on pump impellers, bearings, wear rings, seals, stuffing boxes and the shaft itself, the booklet "MECHANICAL CONSIDERATIONS IN PUMP DESIGN" covers the basic types of process pumps, and discusses the load effects on each. Eight pages, profusely illustrated, this informative reference booklet is now available to engineers and pump buyers. For your copy, send coupon today.

PEERLESS PUMP DIVISION, FOOD MACHINERY AND CHEMICAL CORPORATION
301 West Avenue 26, Los Angeles 31, California

Please send ☐ Bulletin No. EM-79, MECHANICAL CONSIDERATIONS IN PUMP DESIGN
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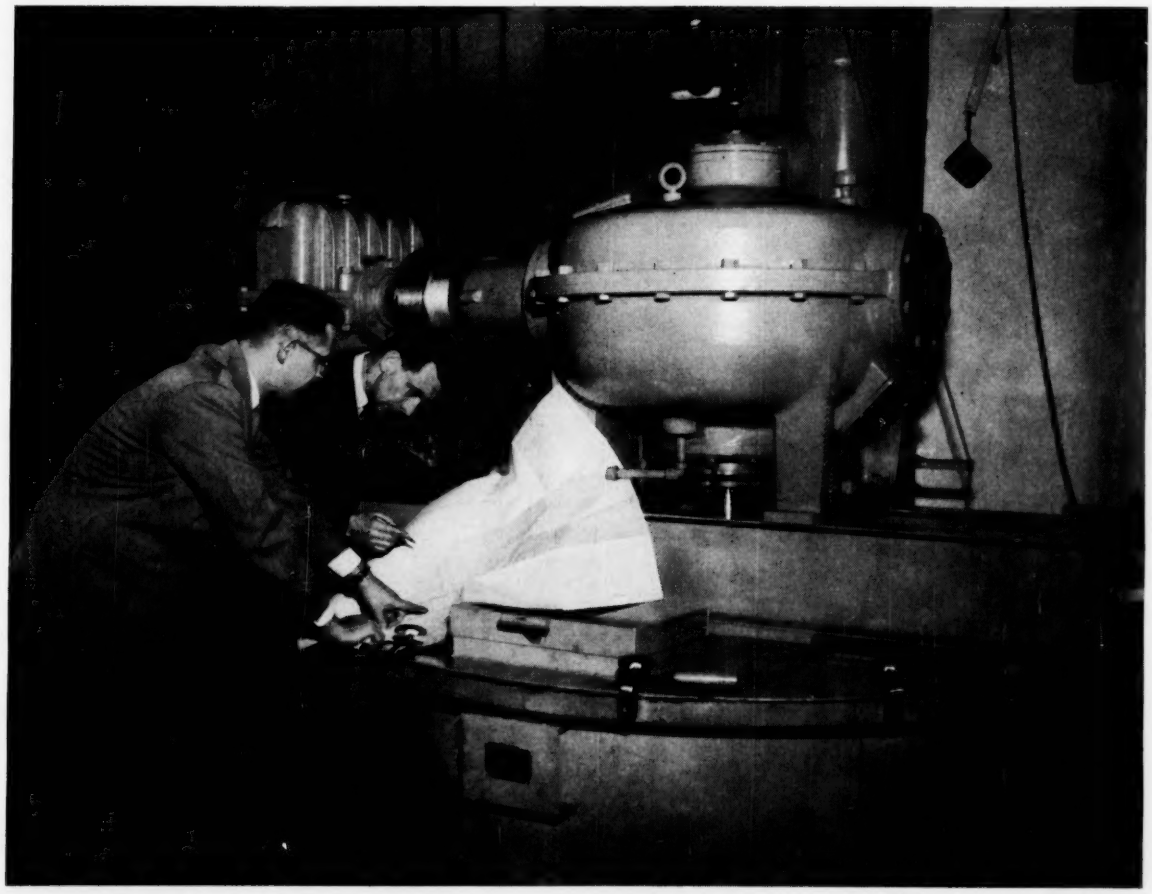
PEERLESS PUMPS



1800 gallon grease kettle features a unique gas firing arrangement that preheats blending oils to speed processing of each batch. Vice President and Plant Manager G. H. Goring (at right) and Blaw-Knox Design Engineer W. E. Luley teamed up to create the cost cutting unit.

Buflovak job-engineered kettle handles bigger batches in less time

Since installing a Buflovak kettle, the Ontario Lubricating Company, Ltd., has stepped-up grease production, cut processing time.

Wherever used, Buflovak kettles turn in profit-building performances because they are engineered to accurately meet job requirements.

Buflovak makes many types of kettles, so their engineers can impartially recommend the best unit based on known specifications and the results of product testing. Temperature, pressure, vacuum, agitation, wall thickness, safety and economy are all carefully weighed. And when custom design is essential, Buflovak brings over 30 years of kettle know-how to the project.

Check your kettle needs at the Buflovak Customer Service Laboratory

If your process is new or untried . . . if you suspect that your operation could be improved, bring your problem to Buflovak's research lab. Here you can work with skilled engineers . . . use the latest in small scale and pilot size equipment to investigate drying, evaporation, extraction, impregnation, crystallization and other related processes.

Write for Catalog 356-R on Buflovak's Processing Kettles, Catalog 381 on the Buflovak Laboratory. Additional facts also available in Chemical Engineering Catalog, pages 429-452.

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Buflovak Equipment Division
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to fit special process requirements

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Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

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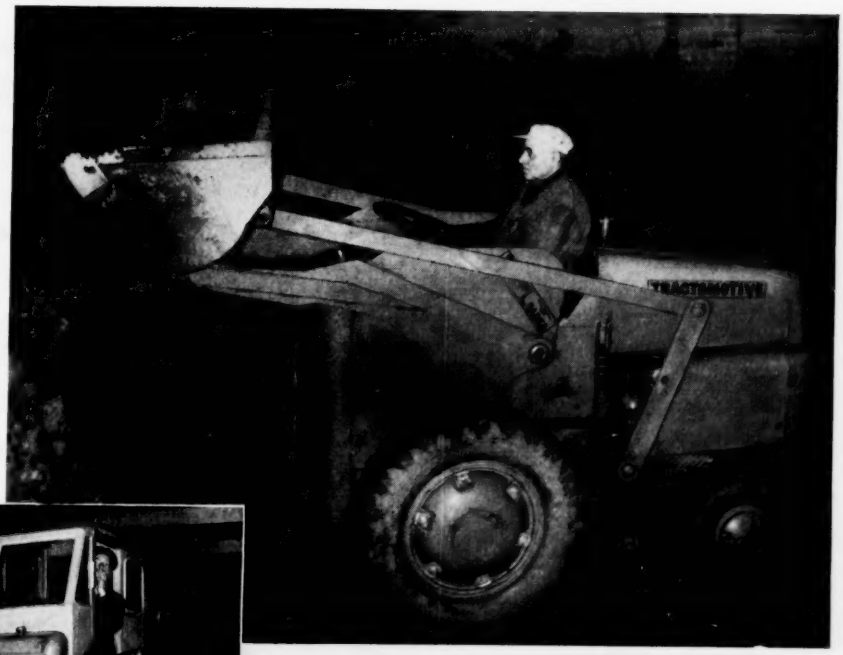
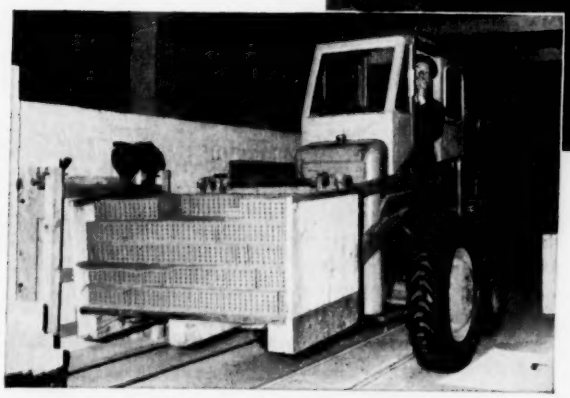
Factory Modernizes Material Handling Methods with FIVE TRACTOLOADERS®

TWO Model TL-6's — each with a ½-cu yd Tip-Back Bucket. (right)

ONE Model TL-6 with a lift fork — interchangeable with bucket. Ideal for transporting materials over unpaved storage area. (below)

TWO Model TL-10's — each with a 1-cu yd Tip-Back Bucket.





In August, 1955, two TRACTOLOADERS went to work for a manufacturer of brick and tile . . . proved their cost-cutting ability so well three more were added. Now five TRACTOLOADERS are used instead of hand labor and side-dump cars to stockpile and transport clay and finished products.

The TRACTOLOADERS have enabled this progressive factory to transfer 16 men to other work. Output in the clay-preparing section has already increased about 25 percent . . . with the loaders only working at partial capacity.

Let your Allis-Chalmers dealer show you how TRACTOLOADERS can modernize your material handling and excavating-loading work. Five models — ½-cu yd to 2¼ heaped capacity.

TRACTO — *a sure sign of modern design*

SOLD AND SERVICED BY YOUR ALLIS-CHALMERS DEALER

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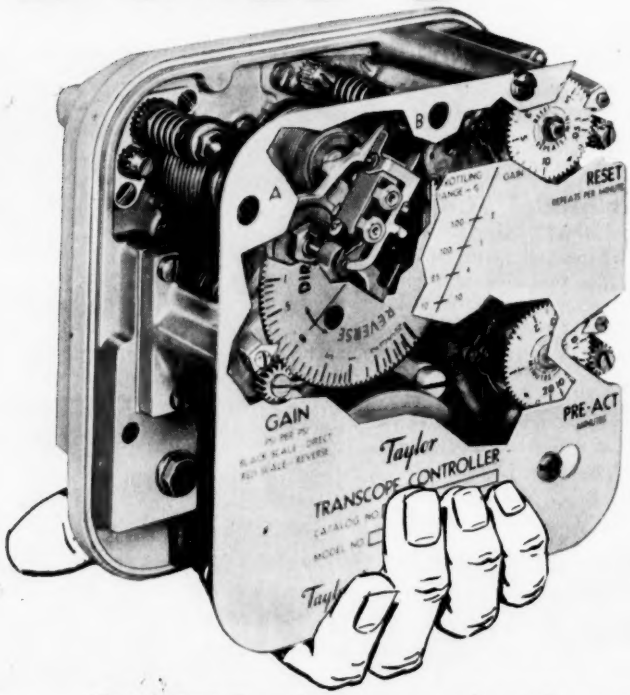
NO DRIFT

Taylor

TRANSCOPE* Controller stands up to vibration and ambient temperatures



ROUGH handling in shipment, mechanical abuse in service, ambient temperatures . . . all are in a day's work for the TRANSCOPE Plug-in Controller. Its motion-balance design eliminates friction by the use of strip pivots, and it is resistant to shock because of its low mass. There's no loading when it's on control point. The large leakless booster relay positively will not stick.

1. EXCELLENT REPEATABILITY—Not only is the instrument extremely stable mechanically, but under widely *varying* ambient temperature conditions it still maintains its repeatability.

2. OUTSTANDING ADAPTABILITY—As well as providing all response adjustments for immediate requirements, the TRANSCOPE Controller can be quickly and simply adapted to changes in operating conditions or processing requirements. Result: minimum inventory of interchangeable spare parts.

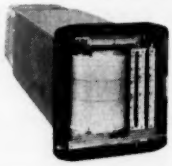
3. HIGHLY ACCURATE RESPONSE SETTINGS—Precision manufacture of gain, reset and PRE-ACT* units permits pre-determined mathematical settings. Same settings in different instruments give same results—extremely valuable on preventative maintenance. Most accurate pneumatic settings available. Response to adjustments is exceptionally fast . . . a big "plus" on start-ups.

4. MAINTENANCE is simple because the motion-balance TRANSCOPE Controller is easy to understand . . . easy to get at. Most difficulties can be remedied without removal or dismantling, permitting speedy, visual alignment. Interchangeable components are keyed to their respective locations assuring correct assembly and alignment. Rugged bellows assembly, keyed in place, moves the dynamically balanced force plate.

IDEALLY SUITED for centralized control, scanning and logging systems. Because of its compactness, stability, responsiveness and simplicity, the TRANSCOPE Controller is a match for your toughest job. Ask your Taylor Field Engineer, or write for **Form No. 98282.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Ontario.

*Trade-Mark

MADE FOR EACH OTHER



The combination of Taylor TRANSCOPE Recorder and Controller gives your operators the best tools possible for the most exacting jobs. *No other recorder, regardless of size, puts so many features in so little panel space.* Write now for **Bul. 98286.**

Taylor Instruments **MEAN ACCURACY FIRST**

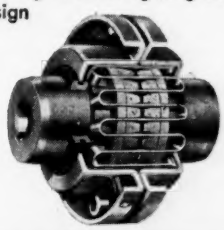
How one FALK coupling saved more than $1,000 per month

Pictured below is a Falk Steelflex Coupling assembly which connects a 2500 hp motor to a reduction unit driving an 18″ bar mill in a Midwestern steel plant. This coupling replaced another type which broke repeatedly, causing maintenance expense averaging $1,000 a month—plus costly production losses. Since installation of the Falk Coupling, with its controlled torque mechanism that disengages when a predetermined overload occurs, there has been no interruption of production. Savings in maintenance and in lost production time are well in excess of $1,000 per month...dramatic proof of the importance of coupling design!

Long coupling life is not the sole criterion of coupling performance. Inadequate shaft couplings may be the cause of bearing damage or shaft breakage on your machines. If so, a change to Falk Steelflex will give two-fold protection to your connected machines: (1) compensation for reasonable degrees of shaft misalignment, and (2) torsional resiliency to reduce peak loads as much as 30%. These advantages are as important to you as the long service life of the Falk Steelflex Coupling itself.

Falk Steelflex Couplings, in types and sizes to meet virtually all industrial applications, are promptly available from distributor, warehouse and factory stocks. Consult your Falk Representative or Authorized Falk Distributor.

Basic **Type F**—cutaway view showing exclusive grid-groove design



THE FALK STEELFLEX ...a truly flexible coupling

Here is the coupling that has all the strength of steel, yet is truly flexible. *More than a million* have been bought for industrial service of many kinds.

Because, in addition to its inherent superiorities of design, the Type F Steelflex can be used horizontally or vertically without modification or special parts, it has been adopted as standard in many plants—and by many designers and manufacturers of industrial equipment...Write for Bulletin 4100.

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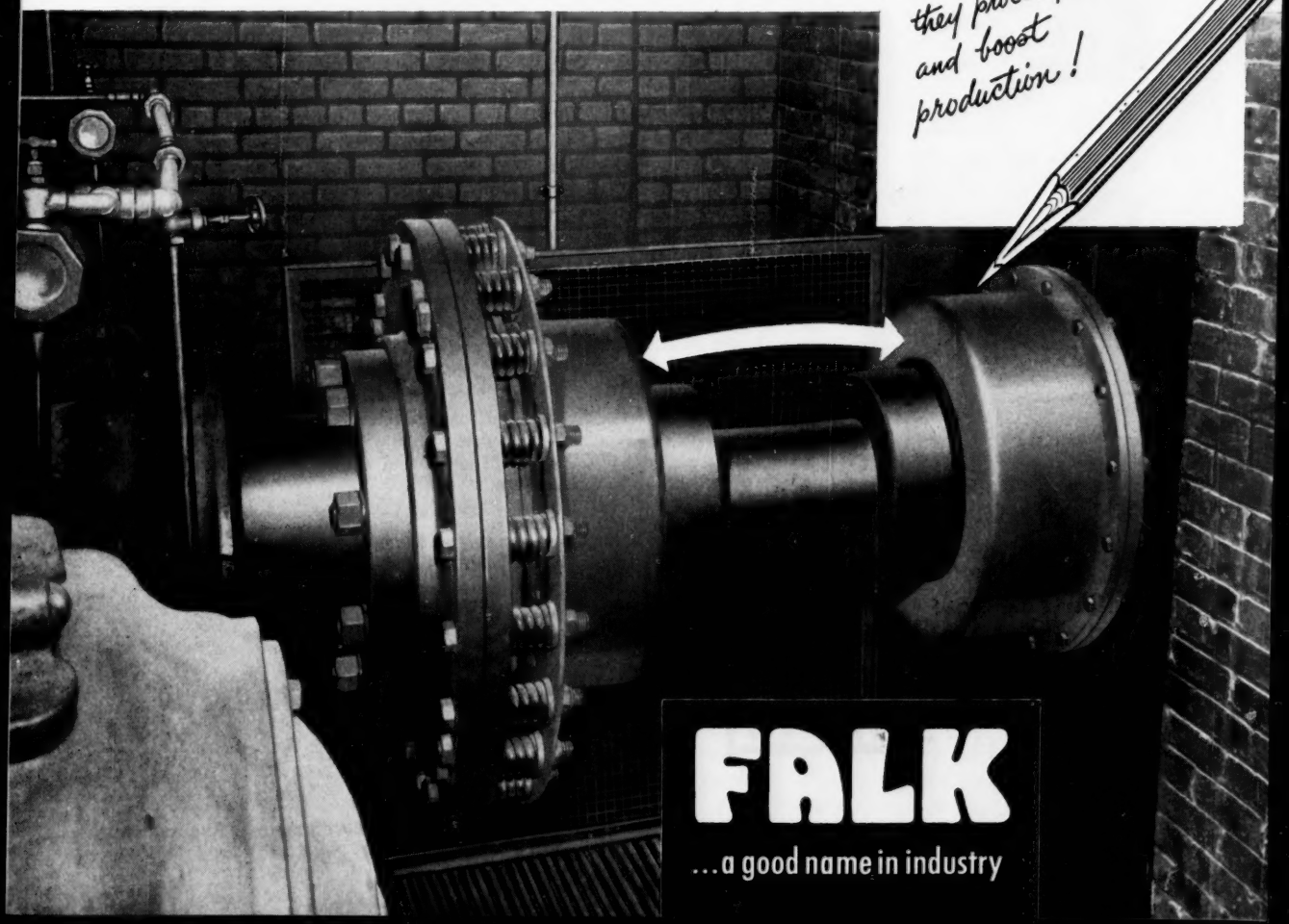
MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in many principal cities

Good couplings not only connect machines; they prolong machine life and boost production!



FALK

...a good name in industry

He may be closing against a fault.
He's not worried...

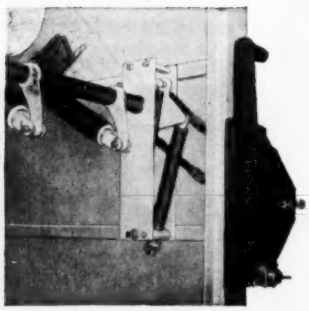
it's an

R&IE POWER SWITCHING CENTER

with the **SAFE HPL-C INTERRUPTER SWITCH**

BUILT FOR SAFE OPERATION—
EVEN AGAINST SHORT CIRCUITS

Some day you may close an interrupter switch against a short circuit. For your safety, and the safety of your equipment, be sure your interrupter switches are HPL-C and operate with TOG-L SNAP mechanisms.



TOG-L SNAP—The high velocity blade operating mechanism. Optional, and important to safe closing-in operation.

RATINGS—Fused HPL-C Interrupters
Up to 14.4 Kv (110 BIL)
400 Amperes—(40,000 Amp. Mom.)
1200 Amperes—(60,000 Amp. Mom.)

SAFETY FEATURES—(1) HPL-C closes in on special heavy closing contacts, outside the interrupter—thus preventing damage to the interrupter switch when closing in on moderate fault currents; (2) High velocity "OVR-CENTR" blade closing (and opening) with the TOG-L SNAP operating mechanism—an optional feature, providing additional safety, important especially during the closing operation. For safety sake, specify these important features.

TESTS—Actual closing against moderate 3-phase fault currents at 4.8 and 13.8 Kv has proven that the HPL-C offers this protective feature. Ask the I-T-E Representative to give you the complete facts and details. They will show real economies on installation, operation and maintenance.

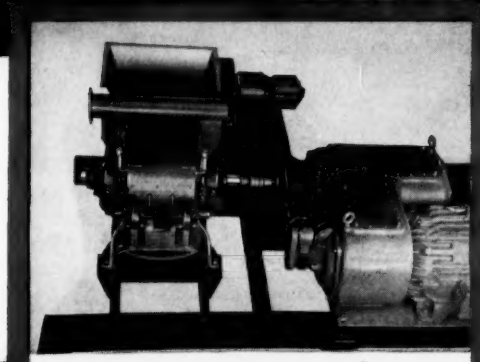
Supplied by leading electrical equipment assemblers, switchboard builders and transformer manufacturers in switchboards and unit substations.

R&IE

R&IE EQUIPMENT DIVISION
I-T-E CIRCUIT BREAKER CO.
GREENSBURG, PA.

HPL-1

Powdered to power the rockets.....



Stainless steel MIKRO-PULVERIZER complete with variable drives and remote controls.

MIKRO-PULVERIZERS are helping to improve and increase the output of rocket fuel materials ground to rigid "space age" specifications . . . easily and safely handling hygroscopic and highly explosive materials such as ammonium and potassium perchlorate. As a result, a uniform finished product can be produced.

A MIKRO-PULVERIZER, operating in a controlled atmosphere, can be incorporated in a completely closed and contamination-free system, with 99.9% *plus* product recovery in a MIKRO-PULSAIRE Collector.

Regardless of what your grinding problem is, we can help you "get it off the ground". The MIKRO-D laboratory will gladly test the material you grind or collect and submit recommendations without obligation. Send today for confidential data sheets. *And ask for Bulletin 51A.*

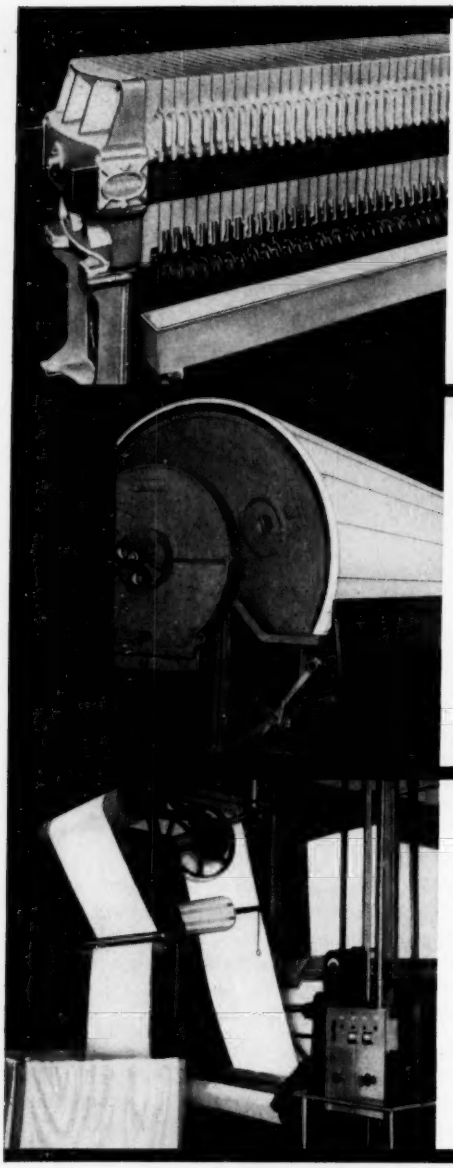
Mikro-D

PULVERIZING MACHINERY DIVISION
METALS DISINTEGRATING COMPANY, INC.
55 Chatham Rd., Summit, New Jersey

GENUINE MIKRO-D REPLACEMENT PARTS AVAILABLE FROM LARGE STOCK WITHIN 48 HOURS

MANUFACTURERS OF PULVERIZING, AIR CONVEYING AND DUST COLLECTION EQUIPMENT

FILTER FABRIC QUIZ



1. Of course you recognize this as a recessed-plate pressure filter. In such filters, where intervening frames are not present, is it true or false that filter cloths must have exceptionally high flex and abrasion resistance?

2. A cotton filter fabric is at work. Which of these is *not* characteristic of untreated cotton fabric: (a) very high wet strength; (b) surface slickness; (c) natural twist for spinning strong yarns.

3. Can you tell what's going on here in the textile finishing plant? Hints: the fabric is nylon, and the process is concerned with dimensional stability.

Here are a few more questions to test your knowledge of some basic filter fabric facts. Even if you score 100, we think you'll find it helpful to remember that you, as a processing engineer, don't have to know all the answers about filter fabrics. That's what we're here for. Wellington Sears people and the filter specialists who distribute our fabrics are always ready to lend a hand in solving your filter cloth problems. And for a handy book of information, write Dept. L-5 for "Filter Fabric Facts."

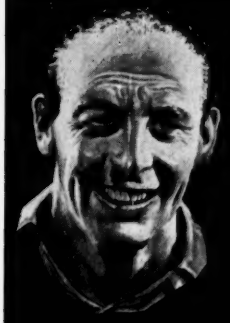
For answers, turn page upside down

1. true
2. (b)
3. heat setting

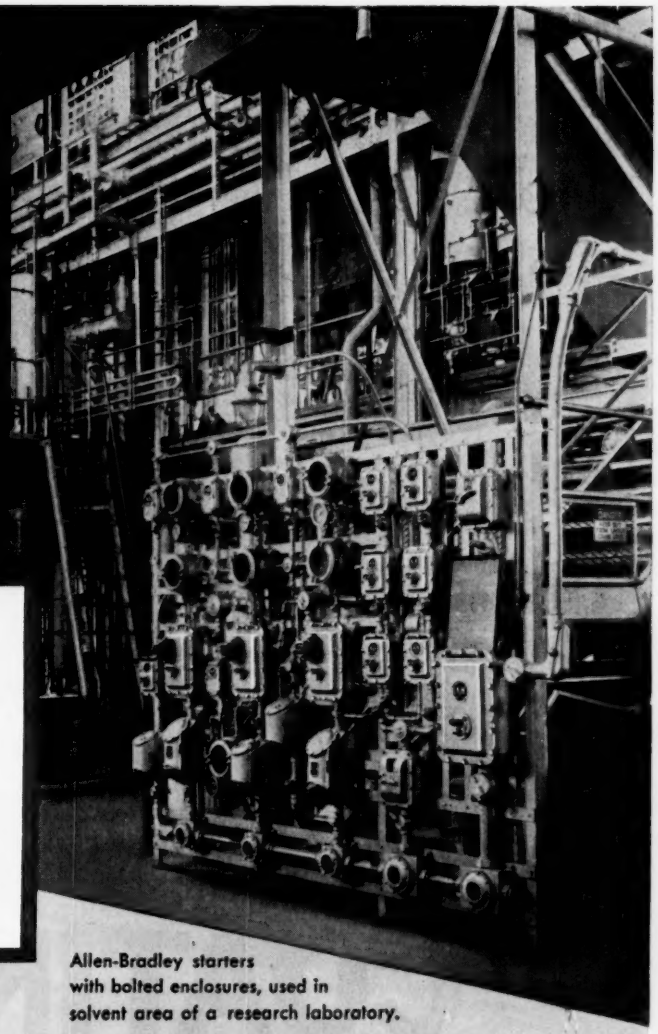
WEST POINT TEXTILES

WELLINGTON SEARS *FIRST In Fabrics For Industry*

Wellington Sears Co., 65 Worth St., N. Y. 13, N. Y. Atlanta · Boston · Chicago · Dallas · Detroit · Los Angeles · Philadelphia · San Francisco · St. Louis

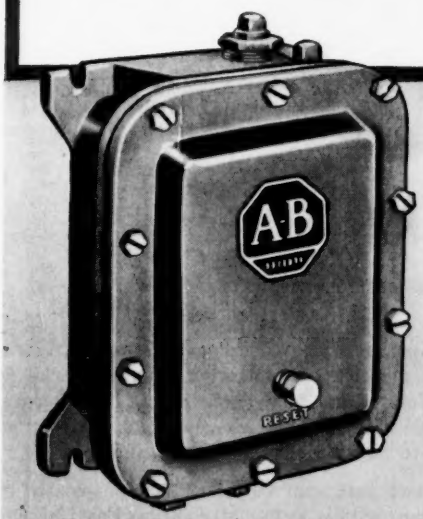


Why waste time taking off starter covers?



Allen-Bradley starters are good for millions of operations... without maintenance

Allen-Bradley starters with bolted enclosures, used in solvent area of a research laboratory.



Bulletin 709 Size 1 Solenoid Starter in NEMA Type 7 explosion-proof enclosure.

The costly job of removing bolted covers for routine inspection is eliminated when you use Allen-Bradley starters. The reason is simple—Allen-Bradley starters are good for millions of trouble free operations! Their solenoid design... with only *one* moving part... has none of the usual trouble-causing parts. There are no bearings to corrode and stick... no flexible jumpers to wear and break. And the double break, silver alloy contacts never need servicing—they are always in perfect operating condition. The overload relays are unaffected by time or atmospheric conditions. Stated plainly—you can install Allen-Bradley starters—and forget them.

Standardize on Allen-Bradley motor control... you *cannot* make a better choice. Please send for A-B Handy Catalog.

A-B QUALITY

ALLEN-BRADLEY

QUALITY

MOTOR CONTROL

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KANIGEN® COATING

protects Hamer "VISIBLE WEDGE" Line Blinds

For positive shut-off in piping systems, engineers have long relied on Hamer Line Blind Valves. These absolute sealing valves provide substantial savings in time and product loss which often repay the cost of the valve in a surprisingly short period of time. When Hamer developed its series of Visible Wedge line blinds, an effective protection of the wedge surfaces against corrosion was desired. After thorough test and study, Kanigen nickel-alloy coating was selected for these surfaces. "Application of the Kanigen coating process," say the men at Hamer, "provides us with an effective corrosion barrier of this vital part, and greatly increases the service life of the valve."

KANIGEN nickel alloy, chemically deposited as a hard, uniform coating, provides corrosion resistance and protection from product contamination wherever nickel is needed. Less costly than alloys, solid metals or clad materials, it can be used in a wide range of equipment—from small valves to the interior of huge tanks and dryers.

Equipment and parts can be jig-coated, rack-coated or barrel-coated at GENERAL AMERICAN plants at East Chicago, Indiana; Sharon, Pennsylvania, and Compton, California.

KANIGEN *is a trademark which identifies chemical nickel coating by GENERAL AMERICAN TRANSPORTATION CORPORATION and its licensees, the product resulting therefrom and compositions produced by them for use in chemical nickel coatings.*

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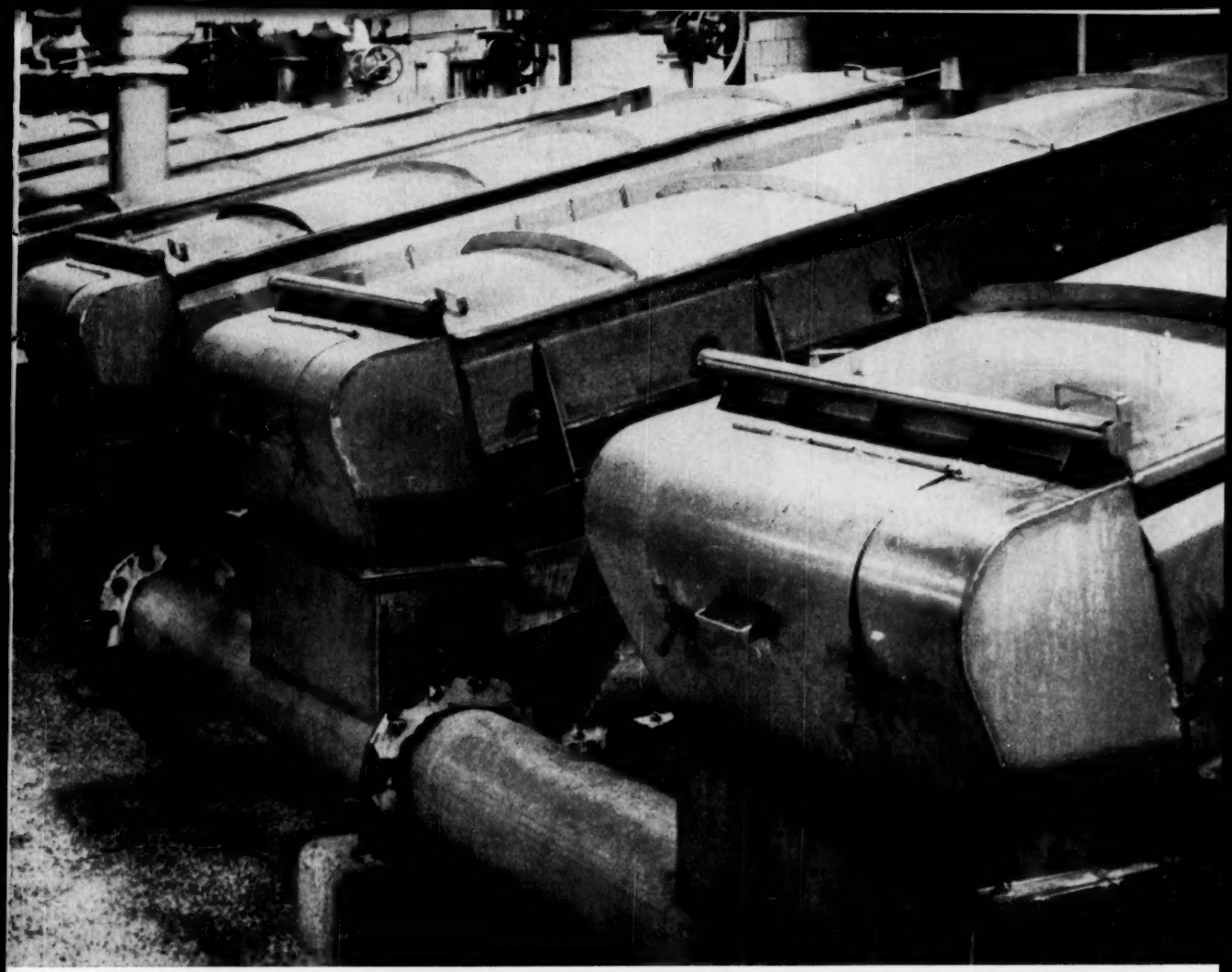


These Stainless Steel bran shakers won't corrode, and they'll last years longer than equipment made of other, less durable materials. Because Stainless Steel is so strong, the new units at Staley's can be made thinner and lighter than comparable equipment made from other materials.

Sulfur dioxide doesn't harm Stainless Steel

at A. E. Staley Manufacturing Company, Decatur, Illinois

Staley's grinds and processes more than 60,000 bushels of corn daily in a continuous-flow operation that demands unfailing performance from every piece of equipment along the line.

And the equipment must be clean, for this corn is made into foods and nutrients. Corn starch, oil and syrup for the food industry must not only be chemically pure, but must be produced with food-grade cleanliness.

That's why company officials, constantly alert for any possible improvement or avoidance of trouble or contamination, were so pleased to find that Stainless Steel solved their sulfur dioxide corrosion problems. Previously the best selection of piping did show corrosion and the sulfur dioxide even attacked tanks of nonmetallic material causing porosity, cracks and corroded equipment. This increased both maintenance and control costs in producing satisfactory products.

Staley's standards called for pipes and tanks that would stay smooth and clean, impervious to the sulfur dioxide. That's why they replaced the outmoded piping and tanks with Stainless Steel.

"Stainless is *the* material for us," says Mills L. Calvert, Staley senior project engineer. "With stainless piping and tanks, I don't have to worry about corrosion or breakdown."

When you replace equipment in your plant, think about strong, corrosion-resistant Stainless Steel. And if you want service-tested quality, specify USS Stainless Steel. For fast delivery, call your local steel distributor.

United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
National Tube—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Warehouse Distributors
United States Steel Export Company

USS TRADEMARK **United States Steel**

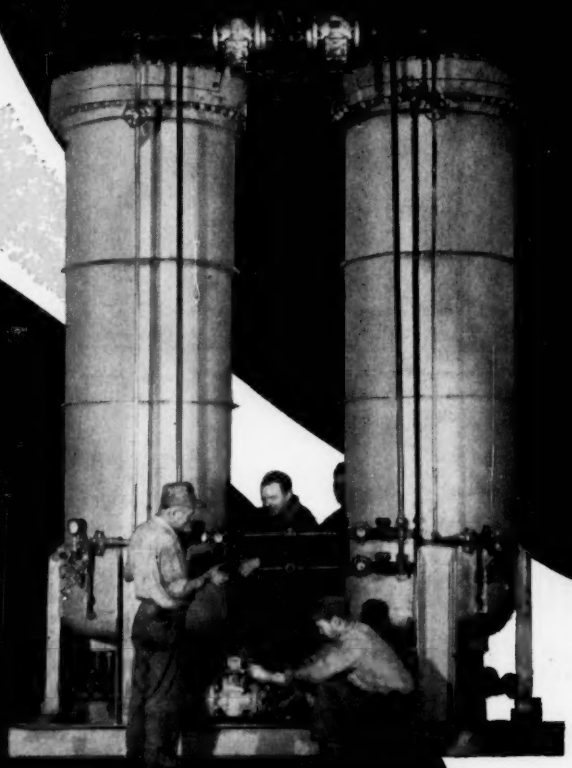
How the full line of LECTRODRYERS can help you save money

YOU don't have to make unnecessary, costly compromises in selecting drying equipment. Drying standards set in development stages can be duplicated in your pilot plant and in full production operations when you use Lectrodryers.

Lectrodryer makes a more complete line . . . more carefully tailored-to-need . . . than any other manufacturer. We can meet your requirements *exactly* . . . supply the type and size drier you need at all stages . . . from test tube to mass production. Consistently efficient, low-cost adsorbent drying is assured with a full line of job-matched Lectrodryers.

This is another reason *leading industries look to* Lectrodryer. For help in dryness engineering call or write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 305 32nd Street, Pittsburgh 30, Pennsylvania.

Tiny 45-pound laboratory Lectrodryer sets process standards of drying.



Production-size Lectrodryers duplicate laboratory conditions.

Leading industries look to

Lectrodryer®

McGRAW EDISON

World's First and Foremost Manufacturer of Commercial and Industrial Adsorbent Driers

BRIEFS for buyers of

Caustic Potash
Phosphorous Acid
Sulfur Chlorides
Cl_2 Wall Chart

Caustic potash—why the package is important

Expose it to air and solid caustic potash soaks up moisture and carbon dioxide swiftly, making the chemical weak and slow acting.

To help you avoid this and to protect the inherent purity of Nialk® caustic potash, we make our own containers to our own rigid specifications.

You can get this exceptionally pure anhydrous caustic potash in any of seven forms at 90% strength or in flake or solid form at 85%. Or you can order the liquid form in strengths from 45% to 52%.

Check the coupon for more complete information.

H_3PO_3
what *can't* you do with it?

Reducing agent, catalyst, plating assistant, intermediate—there's almost no end, it seems, to the tasks you can tackle with *phosphorous acid*, H_3PO_3.

Produced in glass equipment, this Oldbury® product comes to you as a 70% clear water-white aqueous solution, or as a white crystalline flake assaying 97% min., deliquescent and very soluble in water.

We're uncommonly proud of the flake form, which is presently saving one of our customers $45,000 a year in processing costs.

A strong dibasic acid, H_3PO_3 goes into phosphite salts used as plasticizers. It can serve as a catalyst in ether formation, and, possibly alone or with other catalysts, in cross polymerization of olefins and in alkylation of aromatics.

You can use it to deposit nickel and cobalt phosphides in plating; and to prepare dialkyl phosphites.

Are you planning any of these operations? If you feel that H_3PO_3 might ease a problem, use the coupon to request specifications and typical properties. Better still, write us on your business letterhead for a sample.

Sulfur chlorides—*mono-* or *di-*?

Is there an advantage to using a sulfur *mono*chloride and chlorine mixture in place of sulfur *di*chloride?

Yes.

You can purify the *mono-* by simple distillation should you want to. And you can store *mono-* for long periods without gas pressure developing in the container.

Will *mono-* do what *di-* will do? Yes, usually. Actually, you can consider sulfur *di*chloride as a mixture of sulfur *mono*chloride and chlorine.

Naturally, we'll be happy to sell you either the *mono-* or the *di-* as well as our other chlorinating agents, chlorine, sulfuryl chloride, thionyl chloride, and muriatic acid.

Our bulletin on some of these chemicals, *Hooker Chlorinating Agents*, is offered in the coupon. Also available are our technical data sheets on two other chlorinating agents, phosphorus trichloride and phosphorus pentachloride.

New wall chart
helps you handle chlorine safely

A useful addition to your plant safety program is this new Hooker chlorine wall chart.

It can help prevent accidents by showing your employees the most important do's and don't's for handling chlorine. In concise, easily understood language, it explains the operation of tank car, ton container, and cylinder valves; describes safe storage methods; and tells what to do in an emergency.

If you'd like a copy of the chart for posting, ask your Hooker salesman or check the coupon.

For more information on chemicals mentioned on this page, check here. When requesting samples, please use business letterhead.

- ☐ Caustic Potash
- ☐ Chlorine Wall Chart
- ☐ Chlorinating Agents, Bul. 328-A
- ☐ Sulfur Monochloride
- ☐ Sulfur Dichloride
- ☐ Phosphorous Acid
- ☐ Phosphorus Trichloride
- ☐ Phosphorus Pentachloride

HOOKER ELECTROCHEMICAL COMPANY
405 Forty-seventh Street, Niagara Falls, N. Y.

Sales Offices: Chicago Los Angeles New York Niagara Falls Philadelphia Tacoma Worcester, Mass.
In Canada: Hooker Chemicals Limited, North Vancouver, B. C.

HOOKER CHEMICALS PLASTICS

Here's Why...

Silicone Insulated Motors Help Keep Production Moving

When the heat's on production and machines are pushed to rated capacity and beyond, motors get hot too. That's when it pays to have drive motors and essential auxiliary motors insulated with heat stable Dow Corning silicone insulation.

Silicone insulation withstands temporary overloads that burn out other insulation. Insulated with silicones, motors keep going even when pushed 50% above rated capacity, practically eliminating the most frequent cause of work stoppages.

If your plant is automated or has continuous processing lines you can rely on motors insulated with Dow Corning Silicones to keep production moving ahead.

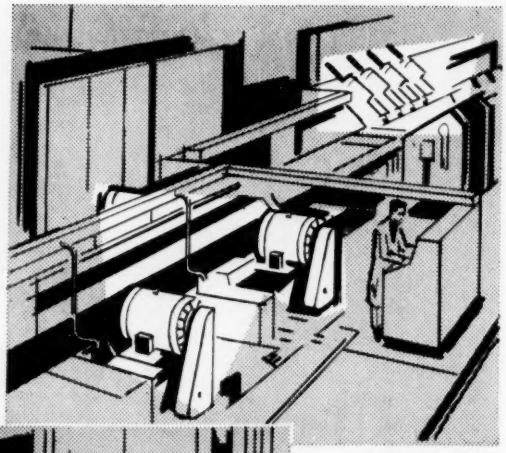
What's more, you can count on reliable motor performance despite high ambients, moisture, plugging, rapid reversing or corrosive atmospheres.

Leading motor builders now offer motors insulated with Dow Corning Silicones. Both ac and dc motors, silicone-insulated for longer insulation life, are available in standard frame sizes.

For maximum reliability and to keep production moving despite the heat of temporary overloads—

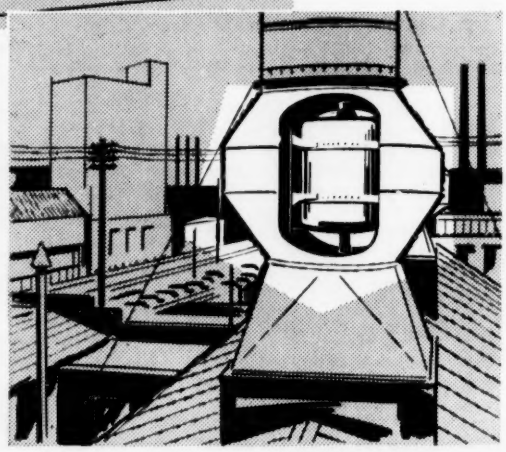
Specify DOW CORNING SILICONES and *Save*

Write Dept. 265a for list of builders who offer Dow Corning silicone-insulated motors.



On production set-ups, where downtime is measured in lost profits, silicone-insulated motors keep going despite overloads.

In continuous processing, fluid handling equipment stays "on stream" despite moisture, overloads and high ambient temperatures.



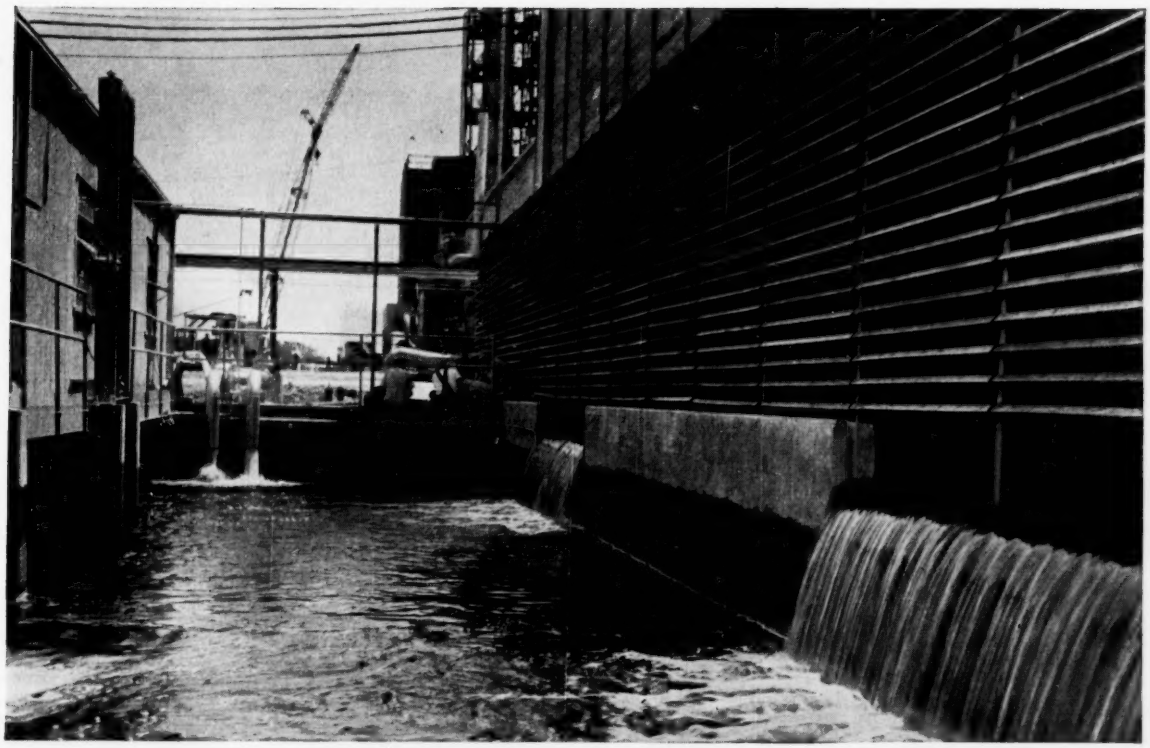
Silicones add reliability to essential auxiliary drive motors. This cupola exhaust fan motor is cooled by oven-hot air.

first in silicones

Dow Corning CORPORATION

MIDLAND, MICHIGAN

ATLANTA • BOSTON • CHICAGO • CLEVELAND • DALLAS
DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C.



How you can be sure to get the capacity you pay for in a cooling tower...

Thousands of gallons of water pour through a cooling tower every minute. If it goes in hot and comes out cold . . . if it keeps a plant's process water reasonably cool—is it safe to assume that the tower is doing its job . . . that the owner is getting his money's worth out of it?

Definitely not!

A tower may actually be operating at only a portion of the capacity paid for—without the owner's knowledge. Its heat transfer efficiency may fall short of specifications. Operating horsepower requirements may be higher than they should be.

How can you tell?

By conducting thorough field performance tests. But if the tower proves deficient, you can correct it only by increasing horsepower or the size of the tower—or both. Even though the manufacturer stands behind his product, you are put to additional expense, you may lose valuable production because of down time during the reconstruction, and your operating power costs may be increased for the entire life of the tower.

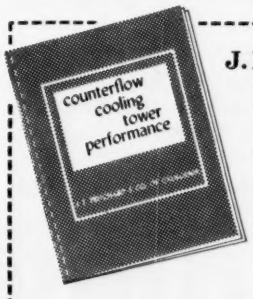
Obviously, the best thing is to *know* the capacity before you buy.

How? Well, you *can* accept the manufacturer's guarantee. But how many manufacturers *really* know? Determining the capability of a cooling tower is an exacting science, requiring highly specialized knowledge of a wide variety of factors influencing performance.

Portions of such knowledge have been published in the past but much has been retained by cooling tower manufacturers as "private and confidential" data. But now, Pritchard has gathered all this information, refined it, added to it field-tested findings from our own research facilities, and arranged it into usable form. This reservoir of knowledge has been published under the title, "Counterflow Cooling Tower Performance," and is available from Pritchard for $3.00. For your copy, mail the coupon below with your check or money order.

No book alone, however, can guarantee cooling tower capacity. That is the responsibility of experienced Pritchard engineers, who translate the information contained in the handbook into cooling tower designs that give you performance, not promises . . . real long-run economy, not first-cost-only economy.

The result is that when you buy from Pritchard, you buy with full confidence that you get what you pay for. You can rest assured that your Pritchard tower will deliver the capacity you specify.



J. F. PRITCHARD & CO. OF CALIFORNIA

Dept. 101, 4625 Roanoke Parkway, Kansas City 12, Mo.

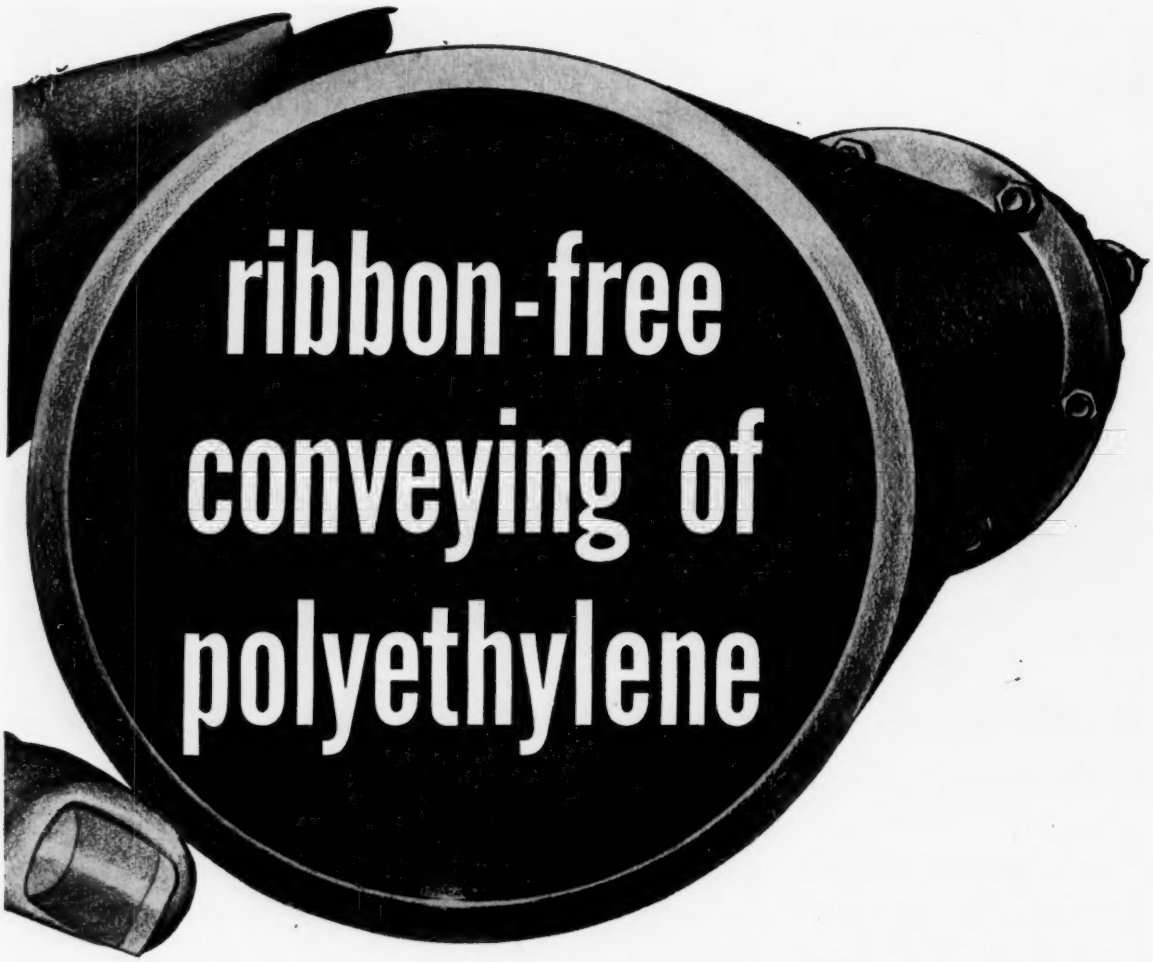
- ☐ Enclosed is $3.00. Please send copy of "Counterflow Cooling Tower Performance"
- ☐ Please send free copy of new Counterflow Cooling Tower Bulletin 4.9.080A
- ☐ Please have your representative call on me

Name ..... Title .....

Firm .....

Address .....

City ..... Zone ..... State .....



New, patented feature of *Airstream* Conveyors

Now Dracco Airstream Conveyors offer you an exclusive feature which eliminates the formation of "ribbons" or "streamers" on pipeline walls in the pneumatic handling of polyethylene and similar plastics.

A special Dracco patented treatment* prevents the linear build-up of polyethylene which occurs in untreated conveying lines. This unique development assures unrestricted material flow and avoids the fouling of extruders, injectors and other production machinery.

Ribbon-free polyethylene conveying is an important addition to the many other advantages of Airstream Conveyors:

- any degree of automation
- contamination-free handling with completely enclosed, air-tight systems
- conveying air can be purified by filtration and drying
- optional controlled atmosphere systems using inert gases
- self-cleaning . . . dust-free
- no moving parts . . . no metal-to-metal contact
- stainless steel or aluminum construction

To be sure of efficient and economical handling of polyethylene—or any high-purity bulk material—specify Dracco Airstream Conveyors . . . now available with the new **ribbon-free** feature.

*U.S. Patent No. 2,784,038

DRACCO DIVISION OF FULLER CO.

4040 East 116th Street • Cleveland 5, Ohio

New 32-page brochure presents detailed information on how Dracco Airstream Conveyors have solved bulk materials handling problems. Write for Bulletin 530.

DRACCO *airstream* conveyors
dust control equipment

HOW'S THIS FOR A TOUGH SERVICE?

The Rockwell-Nordstrom lubricated plug valves shown above handle carbon bisulfide while immersed in water and operated dozens of times each day!

These are the kind of services that ruin ordinary valves so quickly . . . the Rockwell-Nordstrom valves shown above are the *original* valves, not a one has had to be replaced!

Rockwell-Nordstrom valves stay in service longer because the critical seating areas between the plug and the body are *never* exposed to the line. They assure far tighter shut-off than ordinary valves because pressurized lubricant forms an instantly replaceable "soft seat." And, lubricant eliminates metal-to-metal wear for longer valve life, lower cost.

Rockwell-Nordstrom valves are available in semi-steel, steel, stainless, bronze, Monel and other corrosion resisting metals in a complete range of sizes. They cost no more to buy, often less, than ordinary valves. For details, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

ROCKWELL-Nordstrom VALVES

it's **ROCKWELL**

MANUFACTURING COMPANY

Rockwell Manufacturing Company
Pittsburgh 8, Pa.

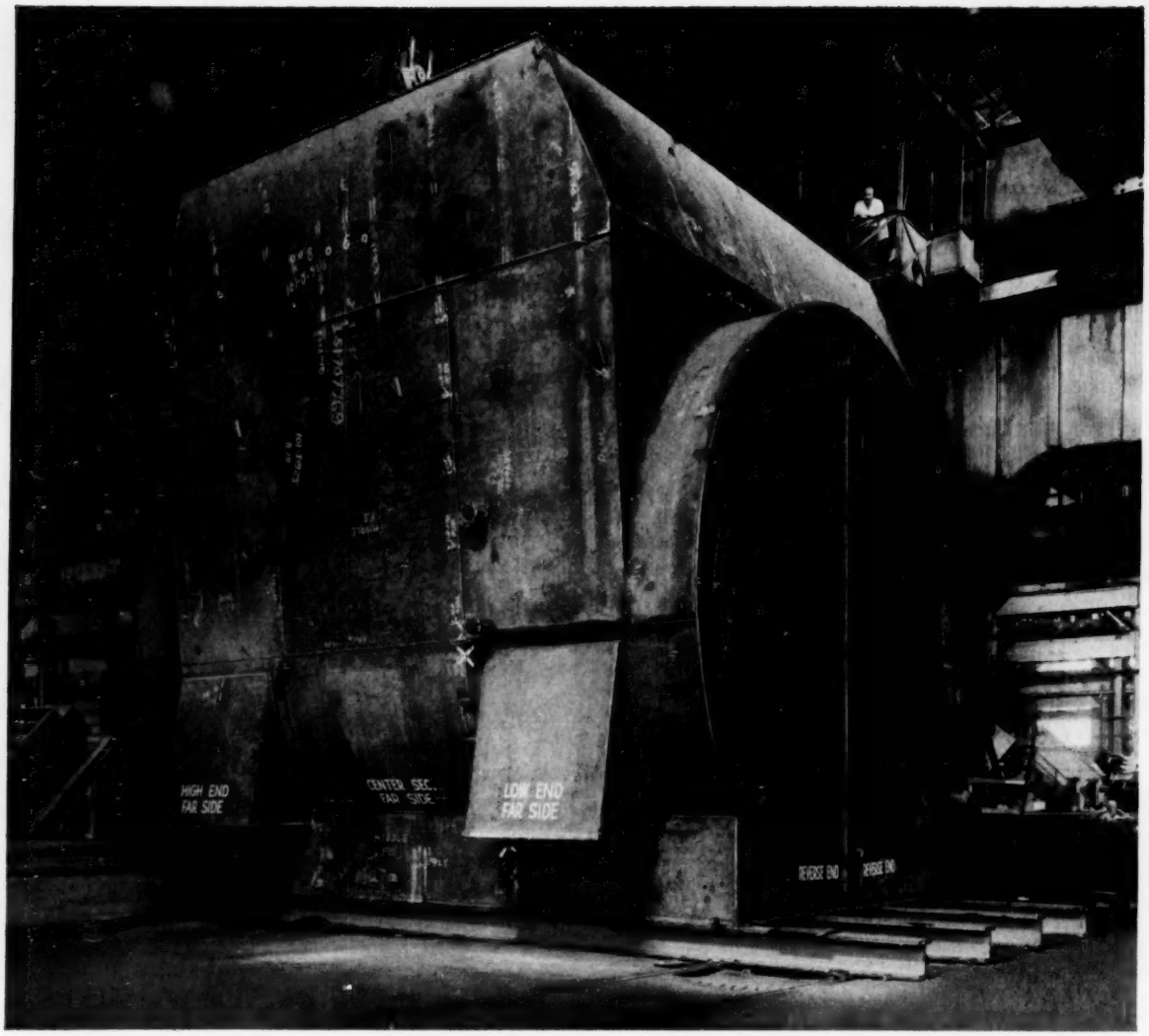
Please send free booklet V-203 ☐

Please have your sales engineer call ☐

Name_____ Title_____

Address_____

City_____ Zone_____ State_____



Operator of overhead crane (top, right) and workmen on shop floor are dwarfed by the enormousness of this surface condenser casing fabricated by B-L-H's Eddystone Division.

No welding job too big for vast B-L-H facilities

No welding job—not even the biggest pressure vessels—is too large for the facilities of Baldwin-Lima-Hamilton's Eddystone Division. The fabricating shop covers 15 acres and is divided into 15 bays, each 80 ft. wide and 100 ft. long.

Sheer size does not, of course, even begin to tell the whole story. From automatic tracer flame cutters to individual hand welders, we have a tool for every conceivable operation. And there is no reason for you to spend money transporting formed parts to Eddystone for welding—or completed weldments to some other shop for machining. We can handle every phase of the job—from design right through to delivery. No wonder so many companies bring the big ones to B-L-H.

Our illustrated Weldment Bulletin 7001 will give you an excellent idea of our vast facilities. You should have it in your files. For a copy, write to B-L-H Corporation, Philadelphia 42, Pa.

BALDWIN · LIMA · HAMILTON

Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings • Special machinery • Bending rolls • Machine tools

News and Notes on...

Good Packing Practice

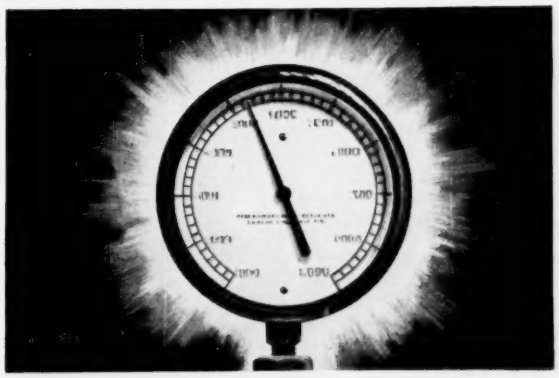
JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: High Operating Pressures

Problem:

How can today's process industries and equipment meet the requirements to stay "on stream" in the face of increasing burdens placed on packings by higher operating pressures?



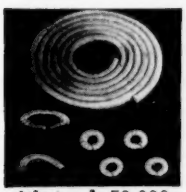
Condition 1

FOR RODS AND PLUNGERS WORKING AT 2,000 TO 3,000 PSI, MOULDED UNEEPAC® RINGS

Wherever reciprocating machinery calls for a minimum of downtime and maximum efficiency in the face of high pressures, Uneepac rings have proved universally dependable. Manufacturer's life tests and applications such as hydraulic presses, pump rods, accumulators, and compressors show Uneepac takes hundreds of thousands of cycles without replacement. Quality materials and carefully engineered design and construction are the key to Uneepac's success in thousands of high-pressure applications. For information on J-M Moulded Packings, write for new, free booklet, PK-126A.

Condition 2

FOR VALVES OPERATING AT PRESSURES TO 5,000 PSI



Tough J-M Chempac® Teflon®-asbestos valve stem packing, Style 2011, combines the heat resistance of asbestos and the corrosion resistance of Teflon. Specify this long-life packing for high-pressure applications to 5,000 psi at temperatures to 500F. In some special cases it has withstood 50,000 psi. You'll find complete details on Johns-Manville's broad line of Chempac Packings in booklet PK-124A. Write for your copy today.

For information on any Johns-Manville Packings and Gaskets, write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

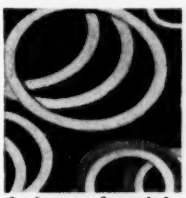
Condition 3

SHEET GASKETS FOR PRESSURES TO 1200 PSI (A QUICK RULE OF THUMB)

To determine whether a job calls for a sheet gasket or a metallic gasket, try the following rule of thumb: "Multiply operating pressure (psi) by operating temperature (°F). If the product does not exceed 250,000, J-M Service® Sheet gaskets can be used. Pressures above 1200 psi or temperature above 850°F, usually call for a metallic gasket." J-M Service Sheet No. 60 effectively seals against heat, cold, water, steam, oils, mild acids and caustics.

Condition 4

FOR STANDARD FLANGE APPLICATIONS TO 6,000 PSI



When you run into the problem of extreme pressures and extreme pressure variations, specify Spirotallic® spiral-wound, metal-asbestos Goetze gaskets. Offering high mechanical strength and resilience, Spirotallic Gaskets seat readily under light bolting. Their special interlocking design and stainless steel construction effect and maintain a tight seal in the face of wide temperature and pressure variations. Write for booklet PK-35A.

JOHNS-MANVILLE

100 YEARS OF QUALITY PRODUCTS ... 1858-1958

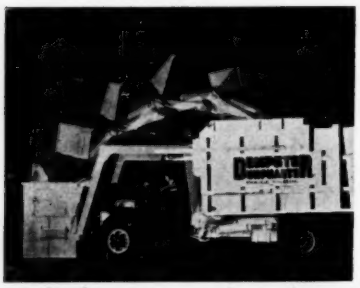
New Invention Cuts Waste Disposal Costs By Two-Thirds in Chemical Processing Plants

Industry Cost Averages May Be Lowered Soon

If your plant is average, you're probably spending between .55 and .85 cents for every cubic yard of waste or trash moved to the disposal area . . . not including truck operation costs.

A recent development, the DEMPSTER-DUMPMASTER self-loading packer, promises to cut direct disposal costs to a new industry low of .07 to .16 cents per cubic yard for volume producers.

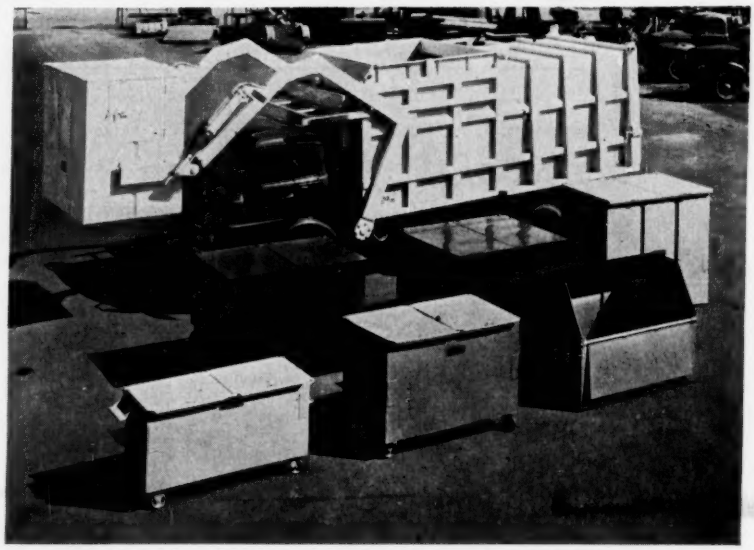
This new approach is an extension of the widely-established DEMPSTER-DUMPSTER System, in that it employs detachable waste storage containers. However, instead of carrying each container to the disposal area for dumping, the new machine empties many containers into its body, where the material is compacted to a fraction of its former volume. This permits per-trip payloads of 50 to 100 cubic yards of loose material, depending on its characteristics.



Multiple exposure photo shows dumping of 6 cu. yd. container.

How it Operates

The one-man Dumpmaster makes its rounds from container to container. Approaching, the driver engages lifting channels on the container's sides with the clearance arms. From controls in the cab, or remote controls at the front bumper, the container is lifted and rotated, discharging waste into the packer body. The material is hydraulically compacted while enroute to the next location. Containers may also be handled from docks or below grade. The safety clearance arms never pass the cab windows, eliminating possibility of driver injury.



The newly developed DEMPSTER-DUMPMASTER is shown with the seven basic containers it serves. Being hoisted is a 6 cu. yd. model. On ground are 1, 2, 3, 4 and 5 cu. yd. designs. Open container is used for hand-loading service.

New "Tracking" Caster Developments Make Plant "Container Trains" Practical

To whip the high cost of moving refuse outside, many plants are going to "container trains." Using special casters and couplers, eight to ten containers are towed by "plant mules" to inside generation points where an empty is dropped off and the full one is coupled on. Outside, the containers are uncoupled and automatically emptied by the waiting DUMPMASTER.

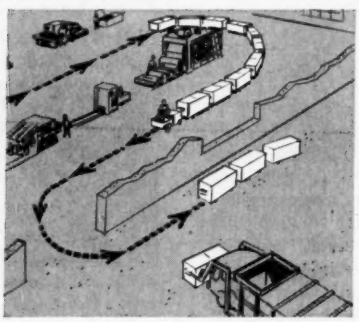


Diagram shows containers, in train, being hauled outside for emptying.

* * *

Many Designs Available

Standard and special-purpose containers, ranging from one through six cubic yard capacity, with or without casters, are available. The two cubic yard container above holds the equivalent of over 12 30-gallon trash cans.

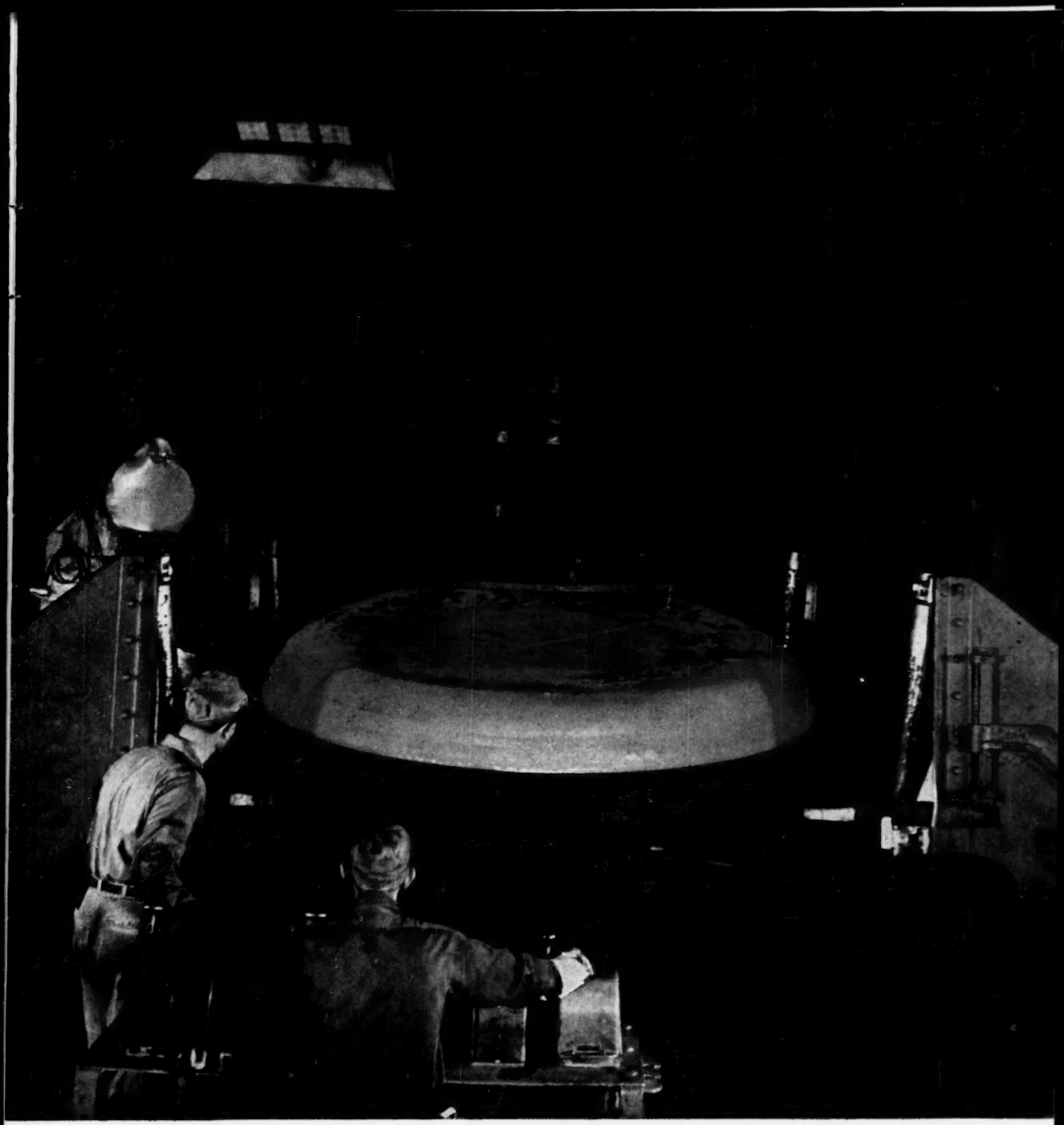
Cost-Finding Book Offered

Write for the free 40-page book, "How to Cut Waste Disposal Costs," offered by the manufacturer. It contains cost-finding formulas, solutions to problems, case histories, industry average costs, etc. Equipment demonstrations arranged on request.

Mfd. by Dempster Brothers, Inc.

DEMPSTER BROTHERS

KNOXVILLE, TENN., DEPT. CE-5



A large diameter steel head takes form on one of Claymont's spinning machines—units that turn out heads up to 19 feet in diameter, in ferrous and non-ferrous metals. Integrated facilities make Claymont a reliable source of quality steel plate and plate products for industry.

by d'Arazien

CLAYMONT SPUN HEADS

CF&I

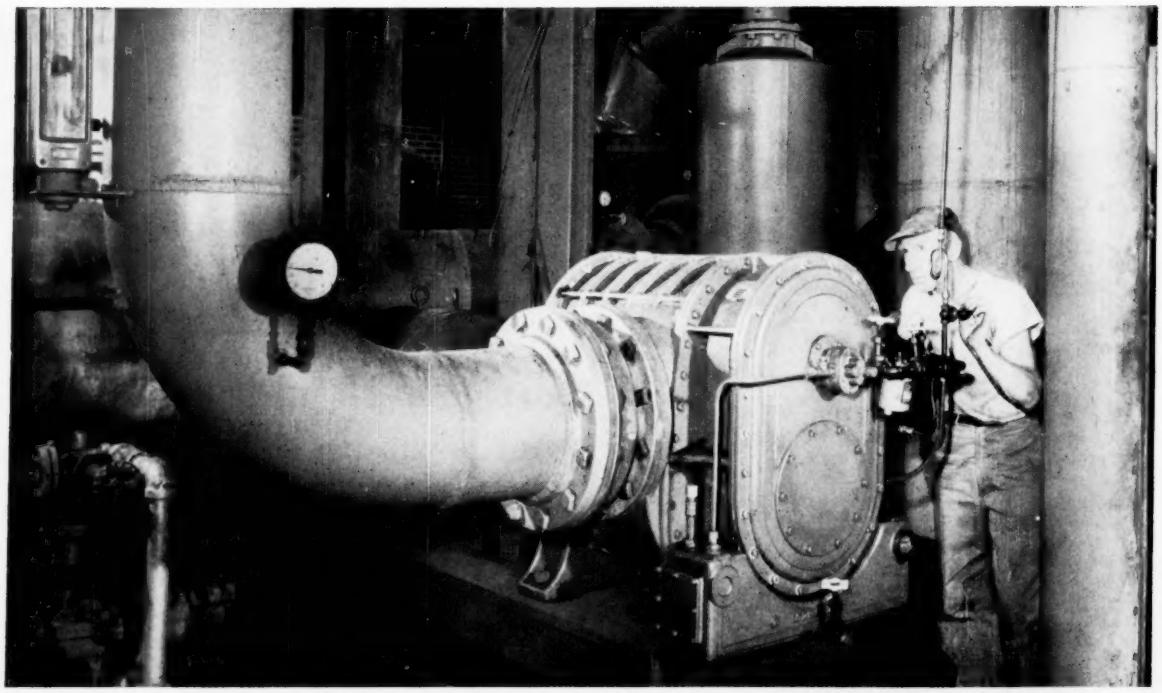
CHECK CLAYMONT FOR—Alloy Steel Plates • Carbon Steel Plates • Stainless-Clad Steel Plates High Strength Low Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Pressed and Spun Steel Heads • Manhole Fittings and Covers • Fabricated Steel Products Large Diameter Welded Steel Pipe

PRODUCTS OF WICKWIRE SPENCER STEEL DIVISION • THE COLORADO FUEL AND IRON CORPORATION

Plant at Claymont, Delaware • Sales Offices in all Key Cities

5745

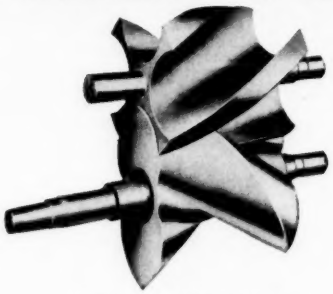
Most compact compressor of its type . . .



AXI-COMPRESSOR in an industrial plant

Use the Axi-compressor

for pressure and vacuum . . . for air, gases, vapors



Rotors of Axi-Compressor

If you are looking for a compact, efficient source of pressure or vacuum, investigate AXI-COMPRESSORS: they provide greater output per pound of unit. AXI-COMPRESSORS may be operated efficiently over a wide range, with low power consumption.

Rotors are of cycloidal form, screw type. They operate with clearances of a few thousands of an inch, but never touch . . . there's no need for internal lubrication.

Operating advantages of this axial-flow, positive-displacement unit includes the following:

1. Compact, rugged construction
2. Smooth, shockless flow
3. No metal-to-metal contact in compression chamber
4. Operating speeds that permit direct-connected drivers in many cases
5. Oil-free delivery
6. Good efficiency over wide range

For complete information on the AXI-COMPRESSOR line for pressures from 25-inch vacuum to 15 psi, capacities from 100 cfm to 15,000 cfm . . . contact your Ingersoll-Rand compressor specialist. Performance curves available in Bulletin 11,001 . . . write for it.

Axi-compressor

Ingersoll-Rand

17-663 11 Broadway, New York 4, N. Y.

PUMPS • CENTRIFUGAL & RECIPROCATING COMPRESSORS • DIESEL ENGINES • AIR & ELECTRIC TOOLS • TURBO BLOWERS • STEAM CONDENSERS

Lower housekeeping costs? Pangborn Dust Control! Here's why!

Yes, this fascinating booklet *tells* you why. It tells you what Pangborn Dust Collectors have done for many different companies in many different fields. How they have cut plant housekeeping costs for these firms . . . lengthened machinery life, improved employee efficiency and morale, reclaimed material for salvage. How Pangborn can give *you* these benefits.

Why Pangborn Dust Control? Because Pangborn offers the most efficient methods of dust collection on the market. Pangborn has spent 50 years dealing with dust problems . . . experience that is incorporated in every proposal. And Pangborn's extensive line of wet and dry collectors means that one of these units can be adapted with maximum effectiveness to *any* problem.

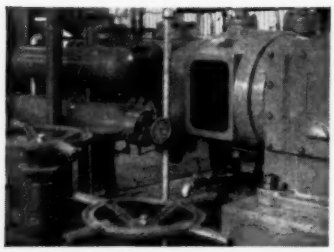
Send for your *copy of "Out of the Realm of Dust." And remember: the Pangborn Engineer in your area will be glad to take off his jacket and go to work on your dust problem at no obligation.* PANGBORN CORP., *2600 Pangborn Blvd., Hagerstown, Md. Manufacturers of Dust Control and Blast Cleaning Equipment.*

Pangborn CONTROLS **DUST**

Pointer oscillation only a minor reason for dampening of industrial thermometers

It is generally assumed that industrial thermometers are silicone dampened solely to prevent pointer oscillation when used on vibrating equipment. True, the prevention of pointer oscillation is necessary, but actually there are several far more important reasons for the use of silicone dampening fluids.

The primary reason for dampening bimetallic dial thermometers is to preserve accurate calibration, especially on the lower temperature ranges where a thinner bimetal element is used. An *un*dampened bimetal element, when subjected to shock or severe vibration, would have a tendency to unwind slightly, throwing the instrument out of calibration. To prevent this, thermometers are dampened by covering the bimetal element with silicone fluid. The silicone provides permanent protection for the critical bimetal element, holding the coil in place and preventing any unwinding or shifting action. This dampening, of course, also prevents pointer oscillation, eliminating difficult readings. But the primary reason for silicone dampening is to help maintain calibration accuracy, and it is therefore quite important to *all* industrial thermometer users.



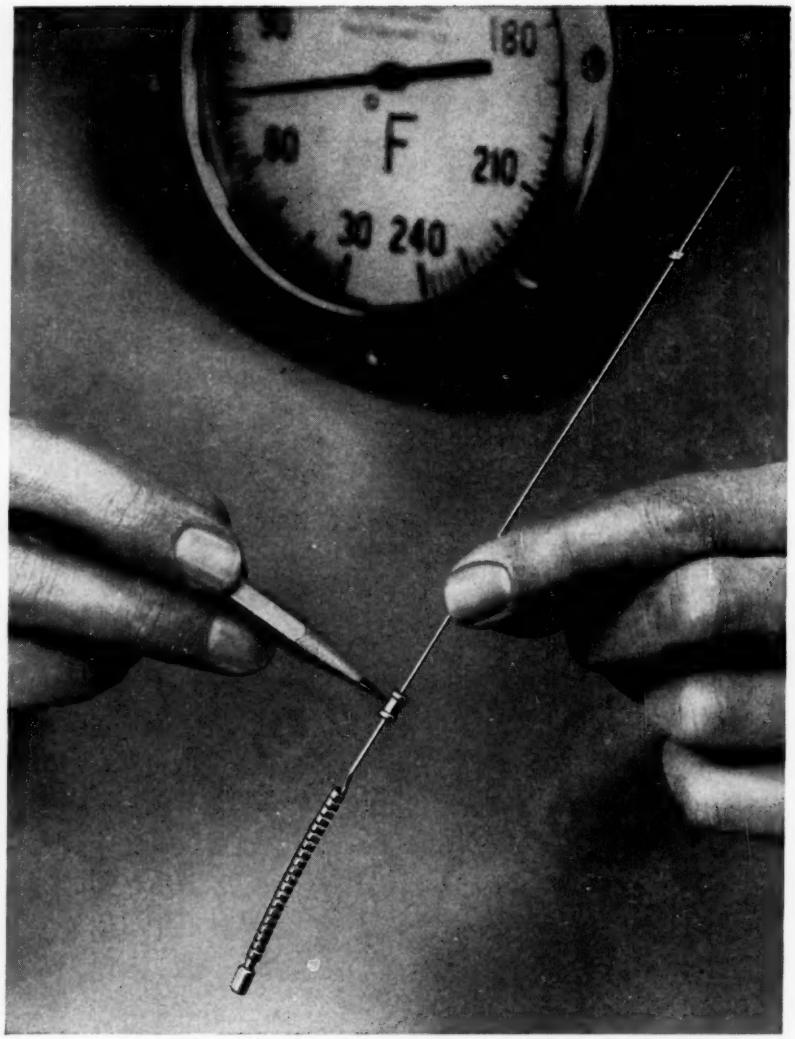
The RMC thermometer in this photograph is constantly subjected to extreme vibration. It is installed on a two-stage Synthesis Gas Compressor in Atlantic Refinery's Philadelphia Synthetic Ammonia Plant. Only a completely dampened thermometer could maintain its accuracy under such conditions.

There is more, however, to the full dampening story. Rochester Manufacturing Company carries this dampening procedure one step further with a specially designed bearing which further dampens both the shaft and coil. It also serves as a better guide for the bimetal shaft to keep it perfectly aligned within the tube. RMC is the only manufacturer using this type of dampening bearing at the present time.

RMC offers compensated electrical remote-reading liquid level indicator

A double coil movement in the RMC electrical, remote-reading liquid level indicator compensates for voltage changes. Silicone dampened and hermetically sealed.

Write, wire or phone—tell us your requirements for indicating instruments, and let RMC engineering skill go to work for you. ROCHESTER MFG. CO., 000 Rockwood St., Rochester 10, N. Y.



This special dampening bearing goes one step beyond silicone in the dampening of RMC thermometers. Only RMC uses this *extra* dampening device in addition to silicone and the usual stamped guide bearings. It is a precision machined part, serving several needed dampening functions.

Special bearing *plus* silicone double-dampens RMC thermometers

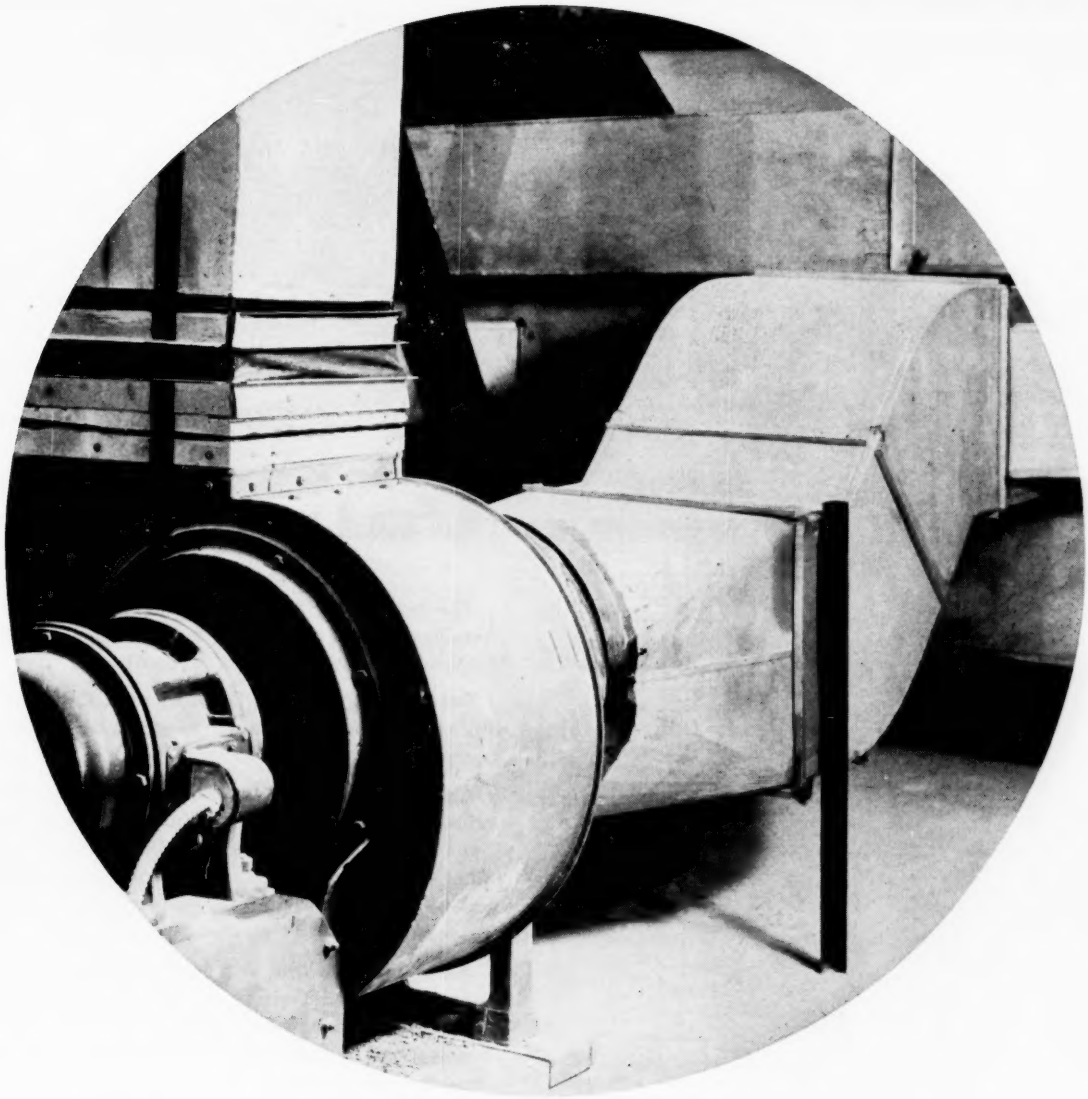
In RMC bimetal thermometers a specially designed dampening bearing is used just above the bimetal element. This bearing further dampens the shaft, helps to prevent coil unwinding and pointer oscillation, and also serves as a better guide for perfect shaft alignment within the tube. It's the combined use of this dampening bearing *and* silicone that makes RMC thermometers extra resistant to shock and vibration. You get this *only* in RMC industrial thermometers.

RMC

ROCHESTER MANUFACTURING CO., INC.
113 ROCKWOOD STREET • ROCHESTER 10, N.Y.

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

REPRESENTATIVES IN ALL PRINCIPAL CITIES



Carpenter Super-Stainless gives long-term insurance against H_2SO_4 fumes, hot acids

You can get outstanding resistance to sulphuric acid and free sulphate ions at up to boiling temperatures with Carpenter Stainless No. 20 & No. 20Cb. In addition, you assure yourself of complete resistance to a long list of strong corrodents.

Available in sheet, plate, strip, bars, wire, billets, pipe and tubing, Carpenter Stainless No. 20 & No. 20Cb is as easily fabricated as ordinary stainless steels. Long-range fume control is guaranteed when you use it for troublesome corrosive-fume ductwork.

Cut costly replacements of corrosion-damaged ducts out of your budget. One installation of Carpenter Super-Stainless will outlast any others . . . economically. Get full details from your nearest Carpenter Representative or send for our latest bulletin or test coupon of Carpenter Stainless No. 20 & No. 20Cb. The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

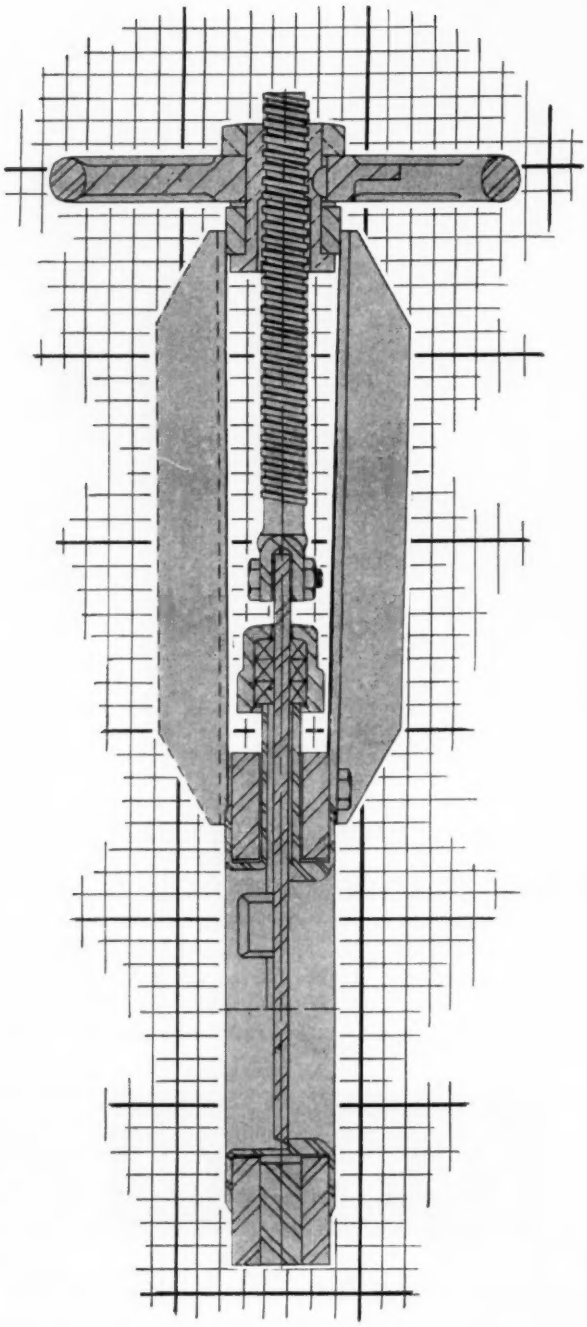
Carpenter No. 20 bars, strip, wire and billets are available also from The Carpenter Steel Company, Reading, Pa.

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

Carpenter

Stainless No. 20 & No. 20Cb

The LOW COST of Valving...



The processing of corrosive chemicals — the handling of acid or alkaline services—has always required expensive valves. . . . until now!

But now. . . . ! DeZurik Fabricated Knife Gate Valves have *high* resistance to corrosion at a low, *low* cost!

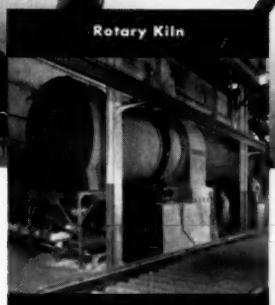
Only the parts coming in contact with the flow utilize high alloys. The remaining structural portions of the valve are produced in mild steel or in other economical metals. (Fabricating out of plate material also eliminates the porosity of cast metal valves.)

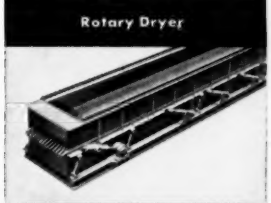
Their light weight drastically reduces installation costs and their bonnetless design all but eliminates maintenance expense. Yet their rugged construction withstands piping strains and line pressure.

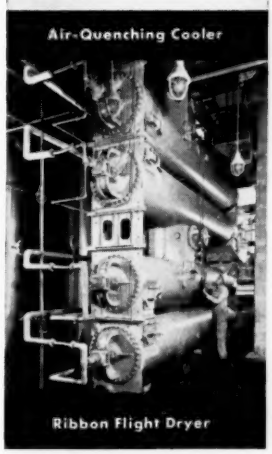
They're available in a wide range of metal combinations and in several different styles. A full complement of operators is also available.

For more information, see the DeZurik representative in your area . . . or write for Bulletin 300.

DeZURIK CORPORATION
SARTELL, MINNESOTA







Heat Transfer Efficiency

...depends on more than equipment

AN array of even the best heat transfer equipment isn't enough. To increase production, lower processing costs and improve product quality, this equipment must be coordinated into an efficient flow design. Allis-Chalmers recommends equipment only after a detailed study of all processing factors.

Call in an A-C Engineering Team

Allis-Chalmers engineers concern themselves with the entire operation: the evaluation of variables . . . plant design . . . the integration of equipment into a complete process. A-C has complete facilities for pre-recommendation research, and pilot plant testing, if necessary.

Expert installation supervision and local field service are supplied by Allis-Chalmers. After installation, Allis-Chalmers provides periodic check-up, maintenance advice and, of course, fast parts service for the life of the equipment.

Ask your nearby A-C man for Bulletin 25C6177, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

Partial list of material processed by A-C heat transfer equipment

Limestone	Alumina	Phosphates	Fuller's Earth
Lime	Bauxite	Refractories	Nickel Ore
Dolomite	Manganese Oxide	Foundry Sand	Copper
Magnesia	Iron Ore	Petroleum Coke	

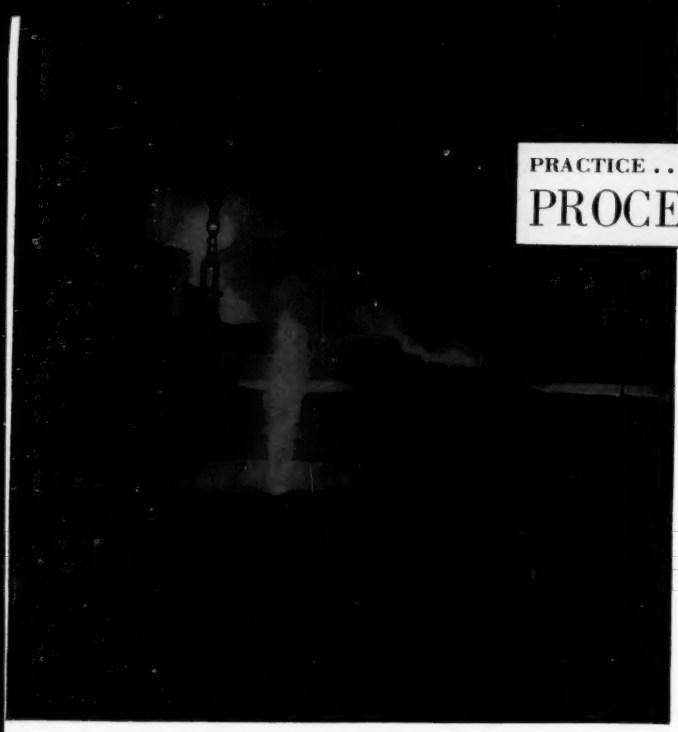
A-C ALLIS-CHALMERS

A-5692

PRACTICE . . .

PROCESS FLOWSHEET

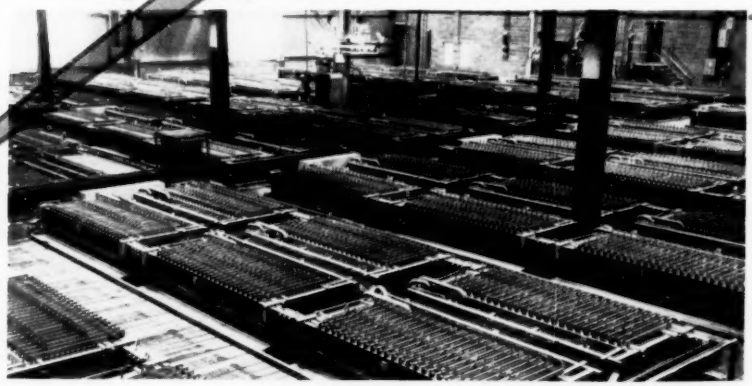
C. H. CHILTON



Low-cost slag . . .

. . . refined by simple process . . .

. . . and put through this bank of cells . . .



Results in:

High Purity Manganese via Electrolysis

Maintaining its position as a leading supplier of alloying ingredients to the steel industry, Electro Metallurgical Co. (a division of Union Carbide Corp.) is now turning out high-purity electrolytic manganese from a 20-ton/day unit recently added to the Marietta, Ohio, ferroalloys plant built several years ago (*Chem. Eng.;* Sept. 1953, p. 134).

Big demand for this new product arises from developments made in the past few years which aim at partial substitution of manganese for nickel in stainless-steel compositions (the 200 series of AISI numbers). Although the Mn content of the alloys could be furnished by ordinary ferromanganese, stringent steel-industry specifications call for an alloying agent much lower in carbon, phosphorus and other impurities than the usual commercial ferroalloy.

Electrolytic manganese fills the bill admirably. Electromet makes it by dissolving Mn-bearing slag in sulfuric acid, separating the impurities by chemical and physical means and electroplating the pure metal on cathodes from which the product is manually stripped.

▶ **Novel Raw Material**—Only other U. S. producer of electrolytic manganese starts with relatively costly, hard-to-process manganese ores. Electromet, on the other hand, capitalizes on its concomitant arc-fur-

Unfold Flowsheet

nace production of ferromanganese as a source of low-cost, easy-to-process, Mn-bearing slag as raw material for making electrolytic manganese.

Slag from FeMn furnace normally contains only about 10% Mn, compared with the more than 50% Mn content of commercial ores. However, it is low in certain impurities (such as iron, nickel and cobalt) which complicate the conversion of Mn ores into suitable high-purity electrolyte. And this slag is readily available at low cost.

In actual practice, Electromet has found it advisable to upgrade the Mn content of the slag to about 20%. This is done by adjusting operating conditions of the FeMn furnace.

▶ **Leaching the Slag** — Molten slag from the FeMn furnace runs through a screen forming droplets that fall into water and solidify. Settling tanks and dryer remove water from the shotted slag in preparation for grinding.

A conical ball mill grinds the slag to a 200-mesh powder. Milled slag is air-blown from the mill and conveyed to an overhead bin.

Powdered slag drops from the bin into a leach tank filled with recycle anolyte and makeup sulfuric acid. Anolyte consists chiefly of ammonium sulfate solution. Ammonia gas bubbled into the leach bath adjusts the pH to 6.

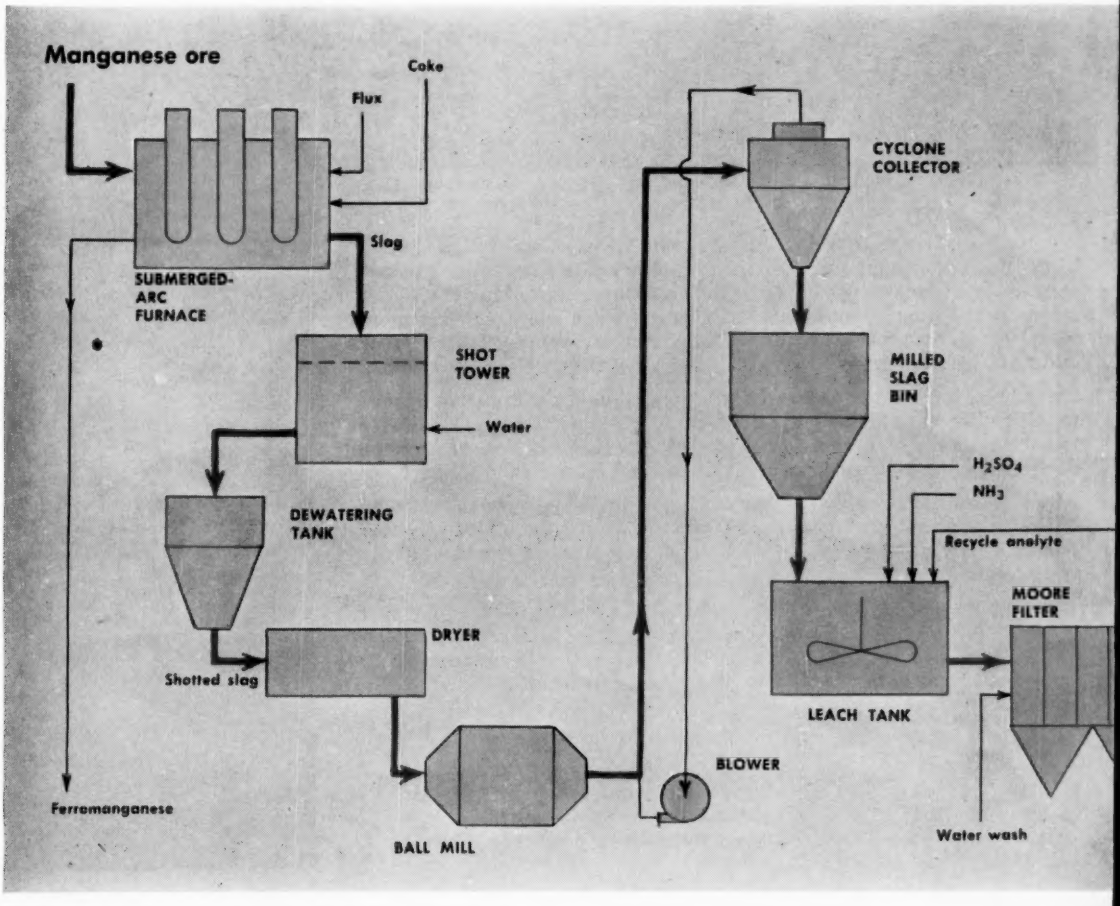
Aqueous phase of the resulting slurry contains, after digestion, ammonium sulfate and 32 g./l. manganese sulfate. Silica, alumina, sulfides of unwanted metals and carbon remain in the suspended solid phase. In order to assure total precipitation of unwanted metals as sulfides, ammonium sulfide may be added to the slurry.

Leached slurry is pumped through a Moore filter.

▶ **Purifying the Solution** — The clear filtrate still contains some dissolved iron, as well as other impurities. It is, therefore, further treated in an oxidation tank. Hydrogen peroxide precipitates out the last traces of iron as oxide. Calcium sulfate seed crystals are added to precipitate kindred crystals, which would otherwise plug cell diaphragms, vents and pipes. Ammonia gas adjusts the pH, while air bubbled in assures total iron oxidation.

Pressure filtration removes the ferric hydrate residue from the oxidation tank slurry. Filtrate goes to a holding tank.

Additives that facilitate the electrowinning process are bled into the cell feed as it leaves the holding tank. In order to render



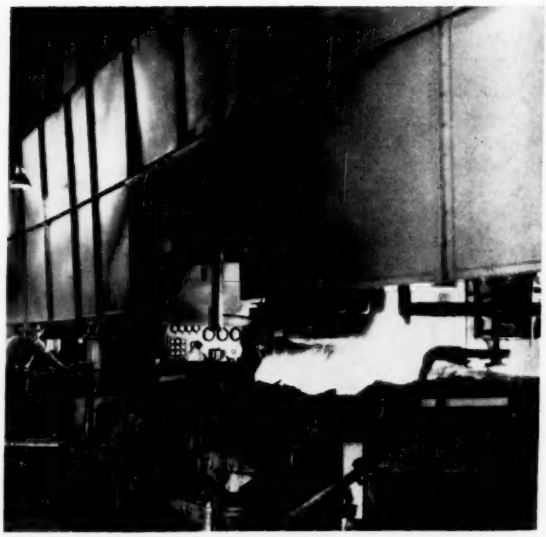
the manganese plate thick, dense and well bonded, 20-70 g./1. of potassium sulfate and 2-15 g./1. of boric acid are required. Sulfur dioxide adds its blessing by stabilizing the electrolyte and improving the current efficiency of the cells.

► **Electrowinning Manganese** — Three banks of 42 cells each win the pure manganese from the cell feed. Each bank is powered by 10,000 amp. at 250 v.; temperature is maintained at 100 F.

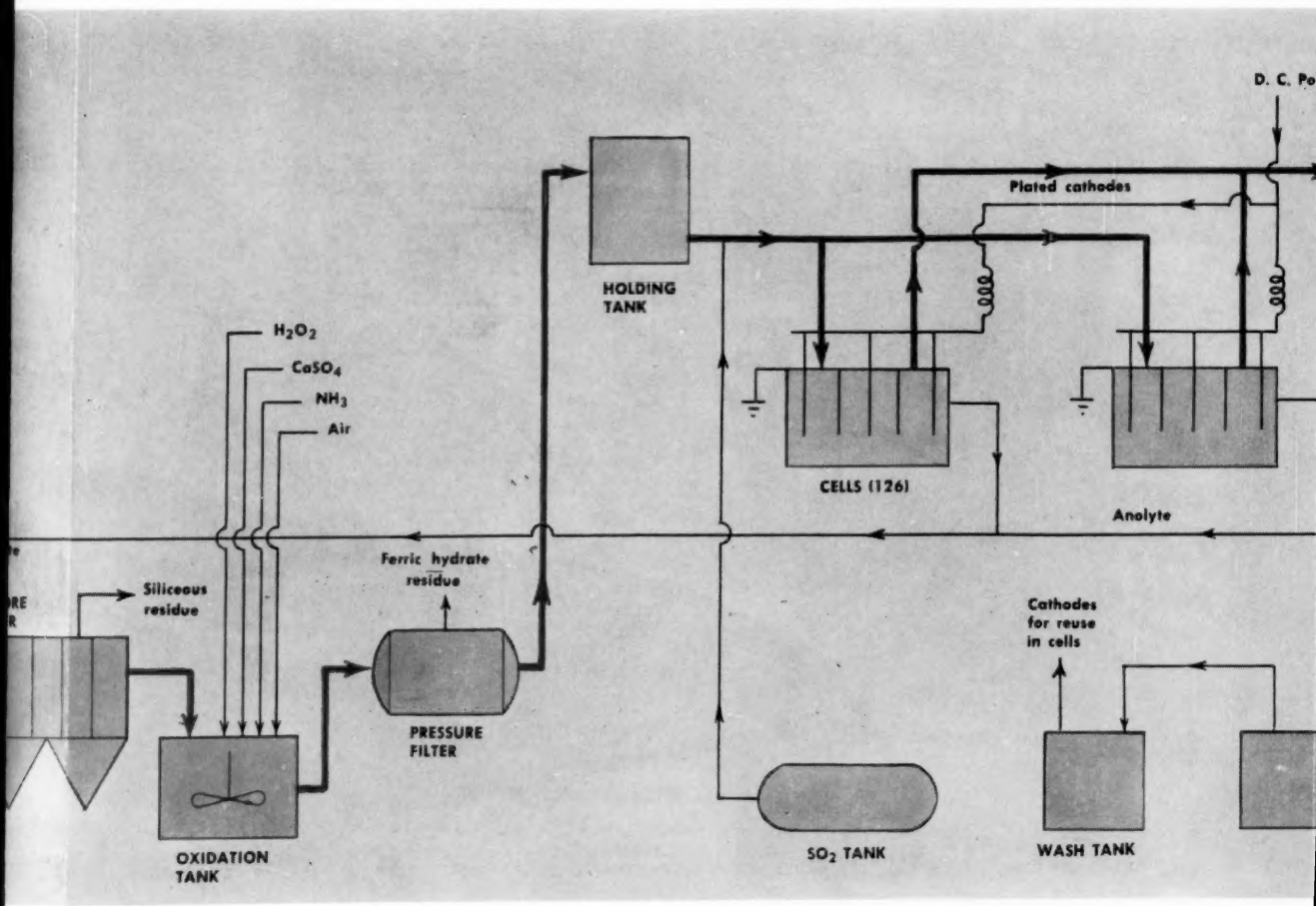
Specially designed, these cells permit the removal of diaphragms without cell disassembly and incorporate a base chamber connected to all anolyte compartments, from which anolyte sludge is easily removed. Anodes are 99% lead and 1% silver; cathodes are stainless steel. New cell tanks now in use are made of a polyester-styrene blend. Light in weight, easily molded in one piece and structurally sound, these cell tanks are unaffected by electrolyte.

► **Stripping the Metal** — On a 72-hr. cycle, manganese-coated cathodes are removed from cell tanks, washed free of impurities and dried. Manual pounding with a rubber mallet loosens manganese plate from the cathodes. Loosened metal falls from the cathodes through a grate in the floor to a receiving hopper. Final step is degasification by heating in an oven to remove traces of hydrogen and other gaseous impurities.

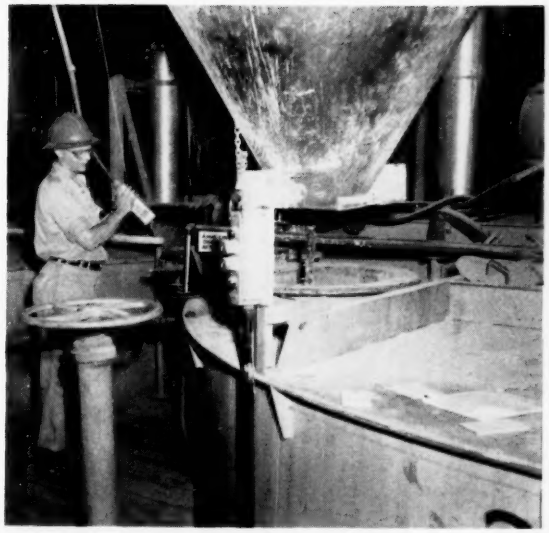
Stripped cathodes are rinsed in anolyte to assure complete scale removal from the plating surface, then water washed before reuse in cells. Periodic mechanical polishing of cathodes is required to maintain the best possible surface for electroplating.



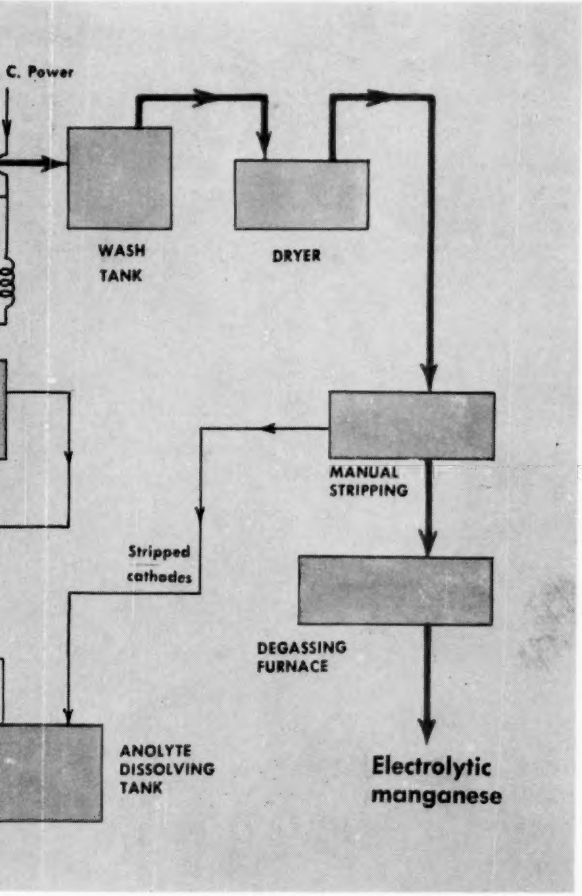
1 ELECTRIC FURNACE: Mn ore is smelted to produce slag and FeMn. Molten slag is then shotted.

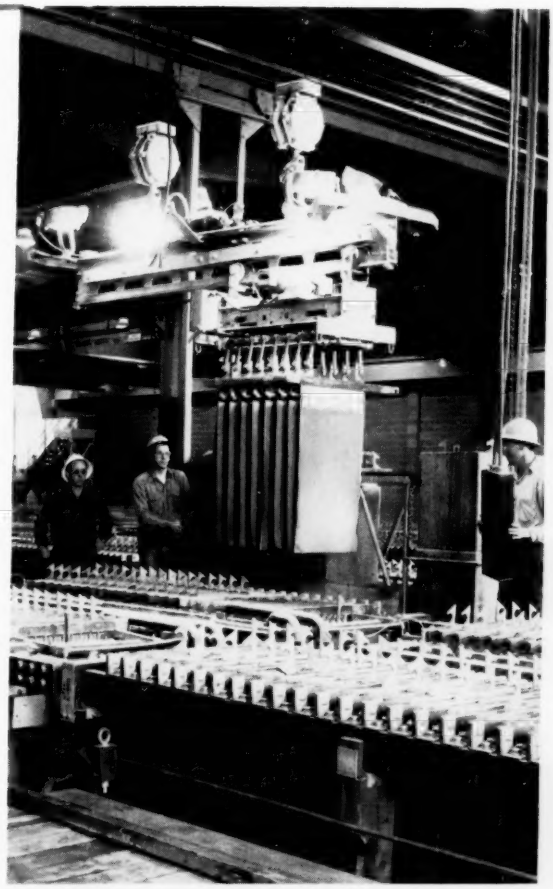


2 DEWATERING TANKS: Shotted slag, divorced here from excess water, is then dried and milled.



3 LEACH TANK: Milled slag enters acid leach bath as first step in preparing pure electrolyte.





1 ELECTROLYTIC CELLS: Manganese plates onto cathodes from which it is stripped manually.

HANS J. ZIMMER
VERFAHRENSTECHNIK
FRANKFURT/MAIN

HANS J. ZIMMER, FRANKFURT/MAIN NO. 14, BORSIGALLEE 1-3

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and in the Production of
Synthetic Textile Fibres

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Among the special items exhibited will be the following:

MOST RECENT SPINNING SYSTEMS FOR VARIOUS HIGH POLYMERS

VACUUM DISTILLATION EQUIPMENT FOR HIGH VISCOSITY PRODUCTS

SPECIAL PRODUCTION CONTROL AND MEASURING INSTRUMENTS

Furthermore, we have organized an ample program of lectures and demonstrations at the research centre of our own premises, covering the processing of polyamide, polyacryl and polyester, ranging from raw materials to finished products, including the most advenced measuring and control systems with their respective instruments. A permanent bus service between the exhibition grounds and our plant will be at the disposal of our visitors.

We shall appreciate receiving your advice if this program should appeal to you in order that we may send you our official invitation enclosing a detailed schedule of the „Zimmer" activities during the Achema Exhibition 1958

Sincerely yours,

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- Nylon 6 - continuous vacuum extraction process
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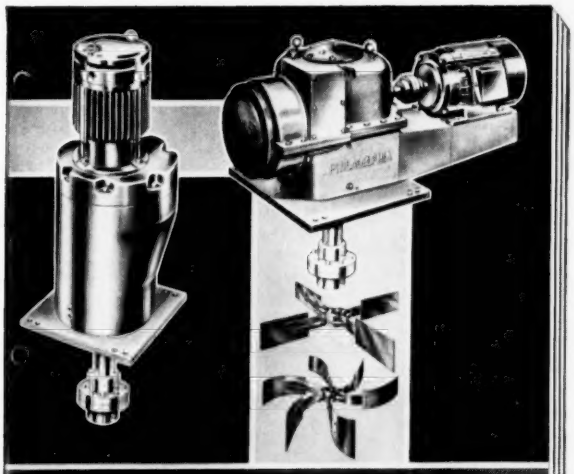

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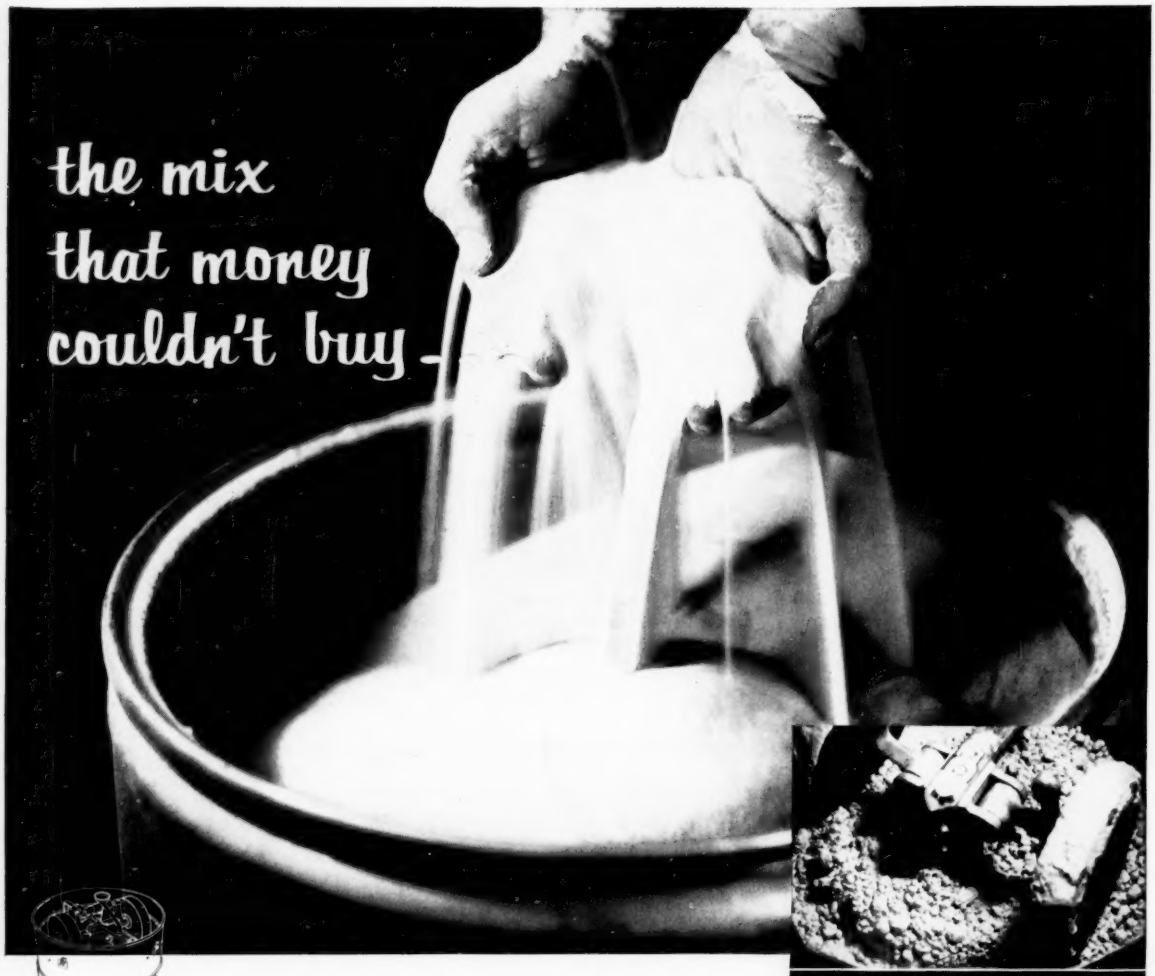
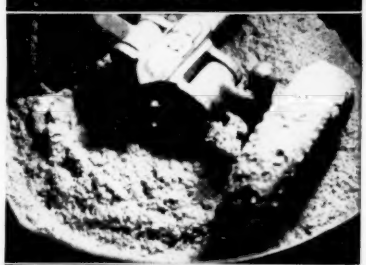
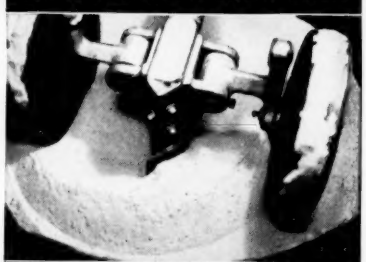
the mix that money couldn't buy



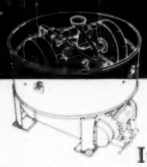
GOING: Mix is wetted. Dispersion of resin-alcohol begins as lumps form.



GOING: Smearing, spatulate action breaks up lumps as mulling action disperses moisture.



GONE: Agglomerates almost gone as blending nears completion. Mix is homogenous, thorough, and quickly achieved.



In the foundry industry the "Shell Process", a special blend of sand, alcohol and resin, is used to achieve a mold which leaves the casting surface extremely smooth. It also insures a casting of uniform strength and dimensional stability. Operators are willing to pay more for raw materials for it because of considerable savings in time, labor and reduced machining costs which the Shell Process makes possible.

They have learned, too, that ordinary mixing practices *cannot be used* in the Shell Process. Controlled, *intensive* mulling in a Simpson Mix-Muller is one of a very few methods of blending which can accomplish the desired dispersion, *without* segregation of resin binder and sand.

Applications such as this one are typical of the way in which *controlled* Mix-Mulling is helping operators everywhere to achieve better blends of critical material with resultant *savings* in raw materials and reprocessing time.

This is why we say—if the Mix-Muller is right for *your* product . . . money couldn't *buy* you a better, *and more economical* blend of materials. Why not write for a copy of: "*Mulling In the Chemical Process Industry*".

SEE PAGES 1263-1266 **CEC** FOR MORE DETAILS

SIMPSON *MIX-MULLER* DIVISION

National Engineering Company

636 Machinery Hall Building • Chicago, Illinois

P-358

Chemical Engineering

Practice

Electrowon manganese from cheap slag 136

By way of a simple process, Electromet wins pure manganese from alloying furnace slag. The cheap starting material makes this electroplating route economically sound.

In rocket and missile technology 145

Many design problems are basically chemical engineering problems—particularly in rocket motors and airframe. This report will show you how your field effects sky-bound flight.

A drafting aid: Photography 161

Here's how one firm gets design ideas across to craftsmen faster and at lower cost, by combining conventional drafting techniques with photography.

Find % conversion without tedious calculations 166

These charts will help you figure the percent conversion for two-, three-, or four-stage reaction systems, in continuous concurrent or continuous countercurrent operations.

Handle Mass transfer coefficients 169

Here's how to make calculations of steady-state mass transfer using mass transfer coefficients—invaluable in the design of extraction and absorption equipment.

These new alloy steels beat process bugaboos 180

Things are really hopping these days in stainless steel technology. All the work on skycraft has resulted in some fine new alloys which combat corrosion and high temperatures.

Your role in the rocket age 187

Where rocket making is concerned, all kinds of engineering specialists get into the act. But if you look closer, you'll find chemical engineers in the starring roles.

MAY 19, 1958

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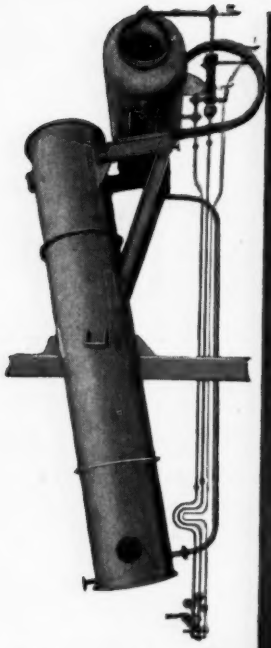


Vertical type unit for a hydrogen plant.

t low cost steam from process-heat

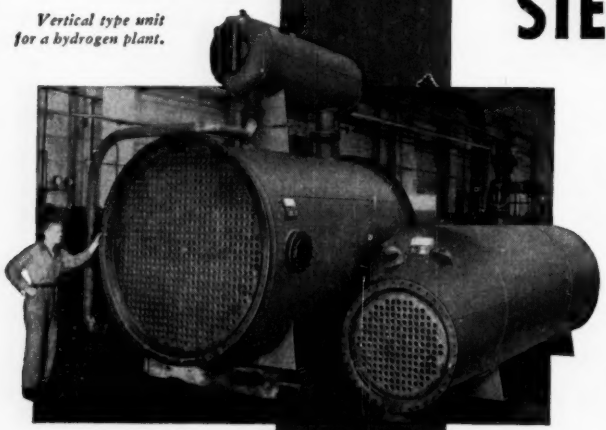
with

CUSTOM BUILT

Vogt

WASTE HEAT

STEAM GENERATORS



A methanol plant operates these horizontal type units.

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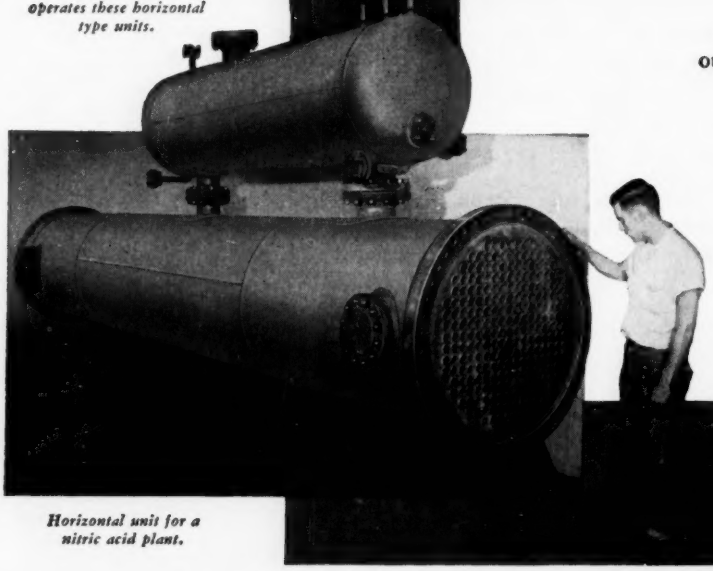

Horizontal unit for a nitric acid plant.

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SPECIAL REPORT . . .
Chemical Engineering
MAY 19, 1958

Chemical engineering developments lead way to big advances in . . .

ROCKETS & MISSILES

The striking progress made in hurtling complicated jet-propelled missiles through the air is due in large part to the solution of chemical engineering problems by chemical engineers. The following 16 pages will spell out the accomplishments and problems that remain.

ROBERT L. NOLAND
Reinhold Engineering and Plastics Co., Norwalk, Calif.*

A missile—be it long or short range—is a complicated, cranky, sometimes erratic acting piece of equipment.

Increasing numbers of missiles —of a tremendous variety—now surge forth from our launching pads, and it is just a matter of time before much of this erratic behavior will disappear. But perhaps lost in the daily headlines is a vitally important fact: missile design is not wholly the province of the aeronautical or "missile" specialists. In many design areas —particularly in rocket motors and airframe—the problems are basically chemical engineering problems, running the gamut from thermodynamics, fuel design and handling to choosing the right material of construction.

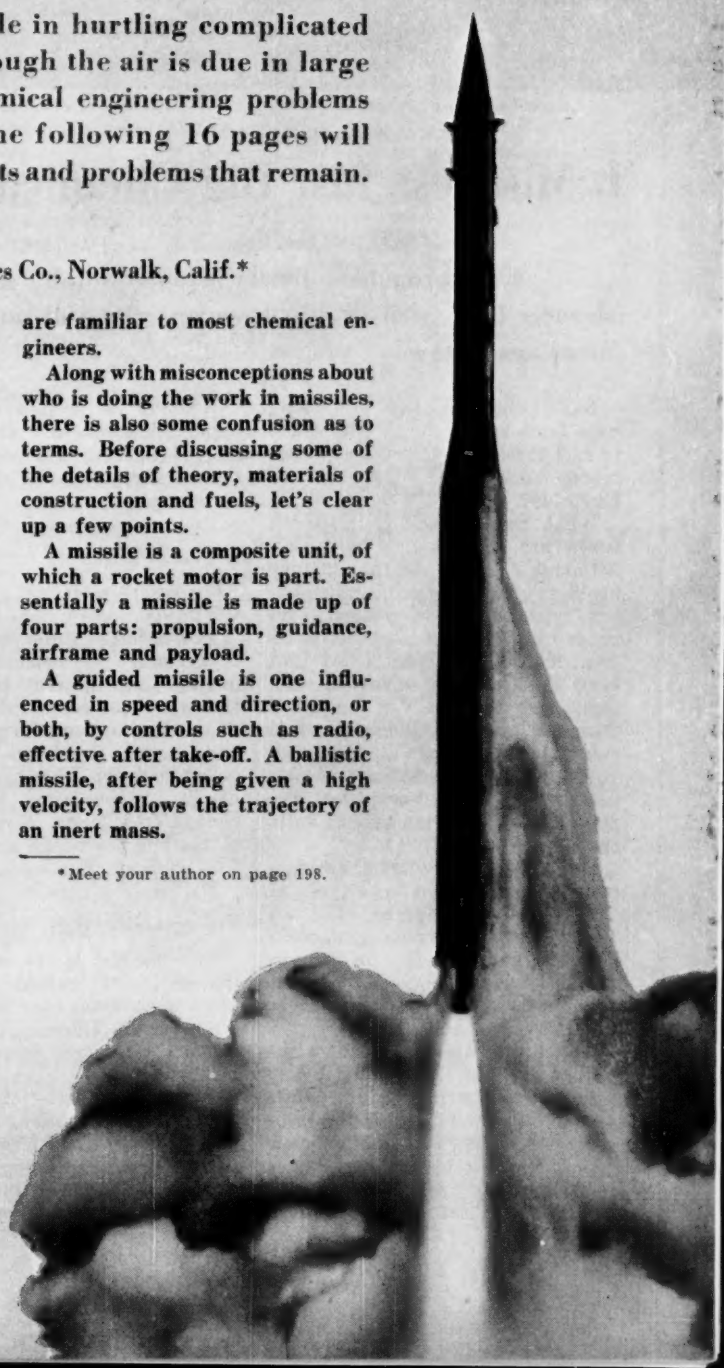
One interesting angle in missiles is the use of plastics for containing high temperatures. Chemical engineers working in this field are satisfied with a material life of minutes or hours—the missile life is not much beyond that. For short exposure times to high temperatures, plastics have worked out, in some cases, better than metallics. Nevertheless, the materials used are familiar to most chemical engineers.

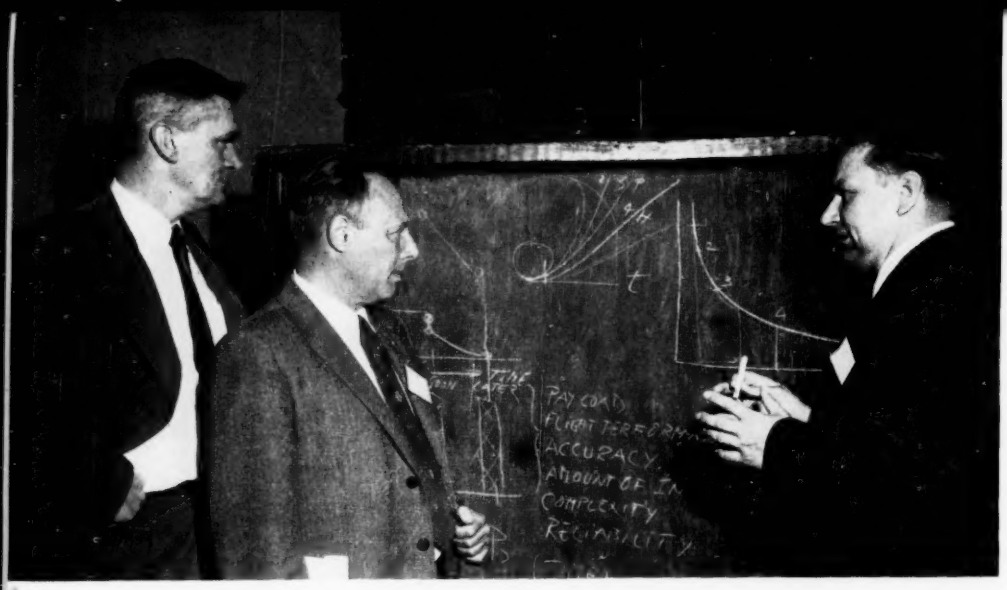
Along with misconceptions about who is doing the work in missiles, there is also some confusion as to terms. Before discussing some of the details of theory, materials of construction and fuels, let's clear up a few points.

A missile is a composite unit, of which a rocket motor is part. Essentially a missile is made up of four parts: propulsion, guidance, airframe and payload.

A guided missile is one influenced in speed and direction, or both, by controls such as radio, effective after take-off. A ballistic missile, after being given a high velocity, follows the trajectory of an inert mass.

*Meet your author on page 198.





CONVAIR engineers discuss problems of missile propulsion.

I. Missiles: Just Big Chemical Reactors

While propulsion theory is important, the big recent advances have been in missile engineering, all pointing to future space travel.

Basic principles of jet propulsion have been known for a long time. In fact the idea was originally conceived back in 120 B.C., by an Egyptian.

What we are seeing in recent times are technological advances. Although it is referred to in history books as a means of propelling various types of crude weapons, jet propulsion did not come into its own until World War II. At that time the Germans came out with their jet-powered V-1 and V-2 weapons, and the Allies with their small barrage and air-to-ground rocket-propelled weapons. Shortly after this, the jet-propelled airplane and jet-assisted takeoff units came into their own.

Out of all this technical development have come two basic types of jet propulsion engines: the air breather engines which carry their own fuel but must rely on the surrounding atmosphere for oxygen, and the rocket motors which carry their own fuel and oxidizer.

Both types operate on the same principles, but involve radically different engineering designs. While most of this work is for the military, it has direct application now in adaption of the new techniques for improved chemical plant design, and for future space travel.

Actually jet propulsion is based upon Newton's well known third law of motion: for every action there is an equal and opposite reaction.

$$Ft = MV \qquad (1)$$

where

F = force; t = time; M = mass; V = velocity.

The equation states that if there is a change in momentum (MV) during time interval (t), a reaction will occur represented by force (F), which imparts forward thrust. This action occurs in a jet propelled device, but here a small mass of gas is subjected to a large change in velocity. Now let's look at the engines which are based on this equation.

Pulsejet Breathes Air

The pulsejet is the air breather that initially gained world-wide fame since it was used as the power plant for the German V-1 weapon, commonly referred to as the "buzz bomb."

Basically the pulsejet consists of a long tube equipped at its forward end with a series of grating-type flapper valves. During operation, fuel is injected into the tube just aft of the valves, but combustion is fired intermittently by an electric spark. When combustion occurs the resulting pressure closes the valves and causes the products of combustion to exit through the tailpipe. As the gases discharge, pressure drops off and the valves open, admitting a fresh charge of air into the combustion chamber.

A schematic sketch of the pulsejet is shown in Fig. 1. For operation this vehicle must be boosted to a velocity where the outside air actually rams itself into the air intake valves. This opens the valves as soon as pressure drops off in the combustion chamber.

Frequency of the actuating cycle depends upon design of the duct (tube) and may be extremely high. For example, the German "buzz bomb" had a cycle frequency of approximately 2,800 cycles/min.

Salient characteristics of the pulsejet are:

- Use. Guided missiles, target aircraft, helicopters and emergency auxiliary power plants.
- Speed range. Although it has a theoretical maximum speed of 2,600 mi./hr., many engineers give the pulsejet a practical maximum speed of 1,500 mi./hr.
- Advantages. Simple design, inexpensive to manufacture, light weight. Operation is relatively easy and trouble-free.
- Disadvantages. Extremely high fuel consumption, vibration, noise and it must be boosted to cruising velocity before the jet can work.

No Valve on Ramjets

The ramjet basic design (Fig. 1) is essentially the same as the pulsejet, with the exception that it is not equipped with a valve at its forward end.

After the ramjet has been boosted to its cruising velocity, air rams its way into the duct and combines with injected fuel. The mixture of fuel and air ignites, creating a jet thrust as the products of combustion exit out the aft end of the combustion chamber.

Except for the possible use of fuel pumps in some advanced designs, or the use of other accessories, the ramjet has no moving parts.

Salient characteristics of the ramjet are:

- Use. Pilotless aircraft, guided missiles, helicopters and auxiliary power plants.
- Maximum speed. Current available data indicate that the theoretical maximum attainable speed is above 5,000 mi./hr.
- Advantages. Simple design and good speed characteristics.
- Disadvantages. It must be boosted to its operational velocity.

Turbojet: Clever Combination

A schematic diagram of the air breathing turbojet engine is also shown in Fig. 1. The turbojet represents a clever combination of the open-cycle gas turbine with the ramjet type engine.

A rotary air compressor mounted forward of the combustion chamber supplies compressed air to the combustion chamber. The compressed air and injected fuel combine and ignite.

This engine also delivers its thrust by the high velocity expulsion of hot gases from the tailpipe. A small portion of the energy of the exiting gases is used to drive the gas turbine which is directly connected to the rotary air compressor.

Salient characteristics of the turbojet engine are:

- Use. High-speed, medium-range fighter aircraft, small bombers and transports.
- Present maximum velocity is 1,500 mi./hr.
- Advantages. High speed, comparatively high altitude and smooth performance. It does not have to be boosted to an operating velocity.
- Disadvantage. Low efficiency at slow speeds; range and payload limited by high fuel consumption.

Rocket Motors Carry Own O_2

There is a big limitation associated with the air breather jet propelled devices. They must rely upon the outside atmosphere for their supply of oxygen. Missile designers look to the rocket motor, which carries its own supply of oxidizer, as the power plant to be used in high-altitude, high-speed, long-range missiles and space ships.

Glossary

BEAM RIDING GUIDANCE
Missile follows a radar beam locked on the target.

COMMAND SYSTEM GUIDANCE
Missile guided by direct instructions from the ground.

GRAIN
A solid propellant charge of fuel and oxidant molded to the desired shape and size to fit a rocket or missile.

HOMING GUIDANCE
Active: missile seeks target by sending out its own radar signals.
Passive: missile picks up signals or radiations given off by target.

HYPERGOLIC
Term describing the spontaneous combustion of materials when simply mixed together, e.g., a fuel and an oxidant that burn when mixed.

INERTIAL GUIDANCE
Missile guides itself on a pre-set course and corrects its own deviations without external help.

LOX
Liquid oxygen used as an oxidant.

LOZ
Liquid ozone used as an oxidant.

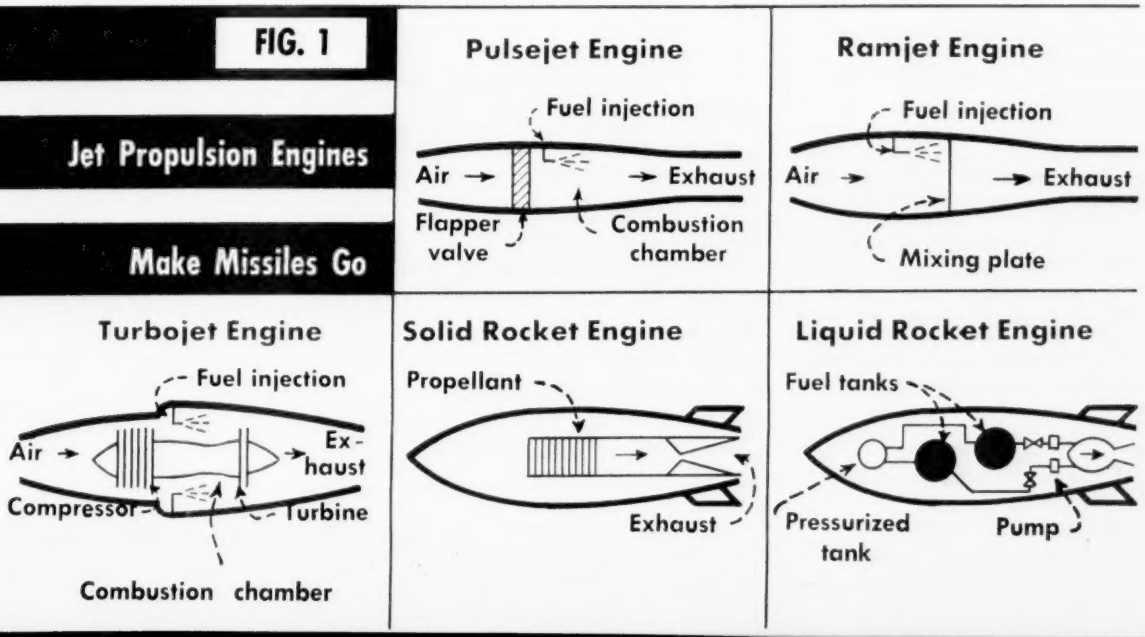
PYROPHORIC
Term describing the spontaneous ignition of a substance in air.

SPECIFIC IMPULSE
A fuel characteristic (sec.) found by dividing total thrust (lb.) by the burning rate (lb./sec.).

WEB THICKNESS
Thickness of propellant grain that must be burnt during combustion.

FIG. 1

Jet Propulsion Engines Make Missiles Go



There are two basic types of rocket motor propellant systems: one uses a solid propellant charge, the other employs a liquid propellant system. Both of these systems are characterized by the violent formation of products of combustion as a result of a fuel-oxidizer reaction in the combustion chamber.

All of the energy generated in a rocket combustion reaction is the result of the breaking of chemical valence bonds and forces in the oxidizer and fuel molecules, and the formation of new and normally stronger valence bonds in the products of combustion.

The energy-producing capacity of a particular propellant system is commonly referred to as specific impulse. Specific impulse is the amount of thrust available per pound of propellant per second. It is expressed in equation form as:

$$I_{sp} = Ft/W \qquad (2)$$

where

I_{sp} = Specific impulse, lb.-sec./lb.
F = Thrust, lb.
t = Duration of operation, sec.
W = Weight of propellant, lb.

From a standpoint of the thermodynamic actions that occur during the combustion process in a rocket motor, specific impulse is also expressed as:

$$I_{sp} = 9.8\left[\frac{k}{k-1} \times \frac{T_c}{M_w}\left(1-\left[\frac{P_e}{P_c}\right]^{(k-1)/k}\right)\right]^{0.5} \qquad (3)$$

where

k = Average ratio of specific heats.
P_e = Exit pressure, psia.
P_c = Chamber pressure, psia.
M_w = Average molecular weight of products of combustion.
T_c = Combustion chamber temp., °R.

For propellants currently in use, specific impulse varies from approximately 150 to 260 lb.-sec./lb., with accompanying chamber temperatures varying from approximately 3,500 to 6,000F.

The Eq. (3) demonstrates that specific impulse is directly proportional to the square root of the combustion temperature and inversely proportional to the square root of the molecular weight of reactant gases. The k factor also enters into effect, but it is not as significant as T_c and M_w.

A high specific impulse propellant implies a high combustion temperature and a low molecular weight of the reactant gases.

This combustion temperature is very important in the choice of materials of construction used in propellant systems. This is especially true for the solid propellant system. Here it is not feasible to employ the fuel as a coolant.

Major Design Differences

A schematic representation of a solid propellant rocket motor is shown in Fig. 1. It is a simple design since it has no moving parts. Its operation is based upon the burning characteristics of the solid propellant. This, in many instances, is a composite mixture of a highly oxidizing solid, such as ammonium perchlorate, and an organic resinous binder. These two basic constituents, along with various additives, are mixed together in metered proportions to form a slurry which is cast into a mold to form the desired propellant grain configuration. This is essentially a large plastic casting, with the oxidizer (approximately 75% of the mix) in place of an inert filler.

A sketch of a typical liquid propellant motor is shown in Fig. 1.

Fuel and oxidizer are housed in separate tanks and are connected to the combustion chamber through appropriate flow lines. For effective operation, rate of injection of each liquid into the combustion chamber must be very carefully regulated. A multitude of valves and regulators are required to obtain accurate metering of the two liquids.

We will now limit our discussion to rocket motors, since they are, by far, most important in missiles.

II. New Materials Contain High Temperatures

Alloys, plastics, ceramics all find their way into missiles for handling erosive, corrosive, high-temperature combustion products.

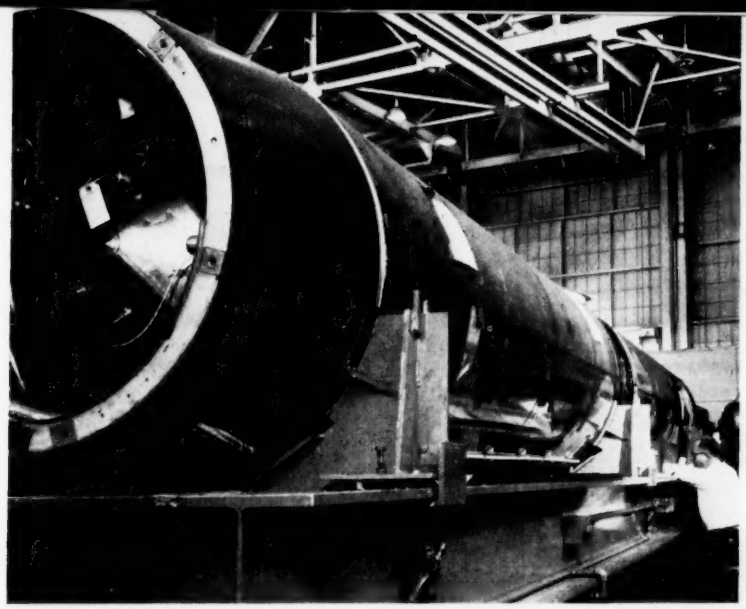
Problems of selecting materials of construction are quite different for solid and liquid fueled missiles.

Majority of solid propellant grains currently used burn internally. These grains are designed for prime burning to progress from the center, radially outwards. Thus, the hot products of combustion are conveyed to the nozzle in passages completely surrounded by the propellant.

Outer peripheries of the propellant grain are inhibited against burning by bonding an essentially inert material to these areas. With an internal burning grain, the hot reactant gases do not come into direct contact with the propellant chamber walls. It is possible to design a chamber on the basis of the cold strength of the chamber material, resulting in light weight cham-

TABLE I Important Missile Materials of Construction

	Density Lb./In.^{3}	Ultimate Strength, 1,000 Psi.	Ratio: Strength-Density
Aluminum alloy (75 ST)	0.11	90	0.82×10^6
Heat-treated titanium (6 Al-4 V)	0.16	160	1.0×10^6
Mild carbon steel (AISI 1020)	0.283	65	0.23×10^6
Heat-treated low alloy steel (AISI 4130)	0.283	225	0.8×10^6
Heat-treated stainless steel (17-7 PH)	0.283	225	0.8×10^6
Glass filament wound structure	0.068	75	1.1×10^6



VANGUARD MISSILE: a myriad of valves, pumps, piping, injectors, tanks.

ber design. The combustion chamber walls are usually below 1,000 F.

Liquid fuels present all the corrosion problems of handling reactive materials, in addition to low-temperature problems associated with liquid oxygen.

But the liquids themselves are used to cool the nozzles of a liquid rocket motor, greatly reducing the problem of selecting the right material. In the solid units there is no such cooling and high temperatures place a severe restriction on choice of materials (Fig. 2).

Keep Weight Down

Over-all weight of any missile is vitally important. A measure of its efficiency is a function of the missile payload and range, compared to its total weight. For one of the new long-range missiles it will be possible to gain eight miles in range for every pound saved.

Since the system for powering a missile constitutes a sizable portion of the missile's total weight, the power plant engineer must design his motor components on a basis of minimum weight, but he must not sacrifice performance characteristics.

Lightweight requirements call for the very best use of available materials of construction.

It is difficult to make a firm statement regarding the selection of a particular material for a given component, since it is usually necessary to tailor each design. For example, it is necessary for the engineer to give consideration to corrosion problems, operational heating, aging characteristics, rough handling preventative measures, feasibility of fabrication as well as lightweight construction. As a basis for preliminary design the engineer usually looks at the strength-density ratio of potential materials of construction. This ratio is essentially a measure of the structural effectiveness of the material, since it is obtained by dividing ultimate strength by density of the material.

Strength-density ratio for typical materials of construction are shown in Table 1. These data indicate that wherever possible, the engineer should attempt to make use of the glass filament wound structure since it exhibits the highest strength-density ratio. Actually, this material has not been prominently used in rocket applications, since it is still under development.

Big Market for Titanium?

Of the remainder of the materials in Table 1, the heat-treated titanium alloy appears to be the most promising. But caution must be exercised in its use since its strength drops off rapidly at temperatures above 800 F.

Extreme difficulties have been encountered in the use of titanium alloys because of fabrication problems, especially in getting satisfactory welded structures. In addition to perfecting new high-strength titanium alloys, it has also been necessary to develop specialized methods of fabrication. For example, during welding titanium oxidizes and becomes embrittled, making it susceptible to cracking. This called for the development of a welding operation where the heated areas are essentially encased in an inert gas.

In new and future rocket design titanium alloys will be used more frequently, especially as liquid propellant and inert gas storage tanks, as well as the solid propellant storage and combustion chamber. In special applications it may find use in the combustion chamber of liquid propellant units. Since its current market price is quite high, it will be used only in special applications until the price becomes more reasonable.

Aluminum Extrusions

The 75ST aluminum alloy has a strength-density ratio superior to the various steels and should be used quite extensively in rocket applications. Unfortunately, this material along with its high strength sister materials, 14ST and 24ST, cannot be welded satisfactorily. However, they can be employed in extruded or forged and machined shapes, such as extruded tubes. For example, millions of 2.75-in. air-to-air rocket motors were fabricated using an aluminum alloy extruded motor tube.

For welded structures we must go to a lower strength alloy, such as 61ST, which has an as-welded strength-density ratio of approximately 5.0×10^5.

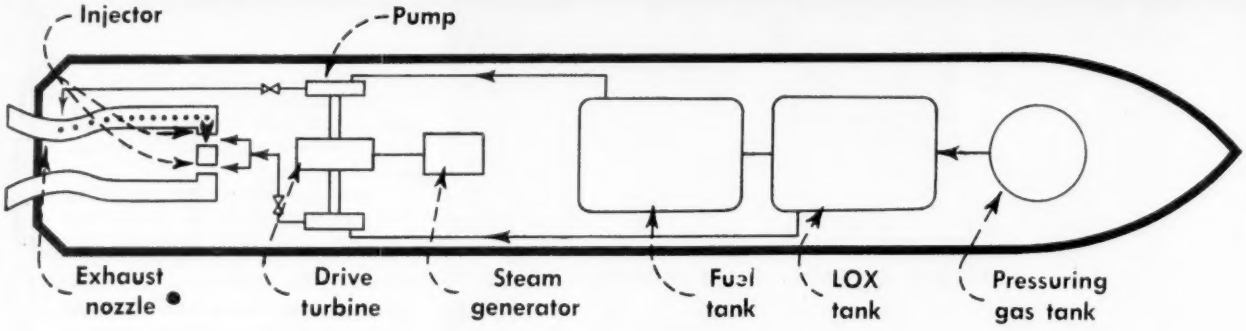
Where the majority of liquid propellants formerly used inert-gas and propellant tanks of aluminum alloy, a majority now use stainless steel tanks. This is a result of a marked improvement in the strength characteristics of stainless steel and also because many of the tanks now form a section of the exterior missile skin. With the high degree of aerodynamic heating imparted to the external skins of the new high-speed missiles, it is mandatory that heat-resistant stainless steels be used.

Aluminum alloys are also used as piping in valve bodies and pump cases, but once again, the new high-strength stainless steels are tending to replace them.

Stainless Improves

During the past 10 years the strengths of the stainless steels

FIG. 2 **Missile's Innards Reveal Power-Packed Chemical Reactor**



have shown great improvement. For example, 10 years ago 19-9DL was the premium, high-strength stainless steel used in rocket motor applications. At room temperature it has an ultimate tensile strength of approximately 130,000 psi. and a strength of 85,000 psi. at 1,000 F. Current stainless steels, such as 17-7PH, exhibit ultimate tensile strengths as high as 225,000 psi. at room temperatures and 130,000 psi. at 1,000 F. In addition, International Nickel Co. has stated that a new stainless steel will exhibit an ultimate tensile strength of 300,000 psi., corresponding to a strength-density ratio of 1.06×10^6.

When it is realized that the stainless steels also exhibit excellent corrosion resistant characteristics, is it any wonder that they are replacing aluminum alloy propellant and inert gas tanks, piping, valve bodies, and pump impeller and casings?

Fabrication deficiencies encountered with aluminum alloys are not present with the stainless steels since it is possible to achieve high-strength welds and high-strength cast sections.

All current major liquid propellant units employ stainless steel combustion chambers, nozzle sections and injector plates. Also, the majority of the gas turbine units employed to drive liquid propellant pumps are fabricated from stainless steels.

Stainless steels have not been widely used in solid propellant applications because in most applications the less costly low-alloy steels are satisfactory.

Severe Solid Problems

Majority of the current solid propellant units use combustion chambers and nozzles fabricated from a low-alloy steel, such as AISI 4130. Since the keynote to each design is minimum weight of inert parts, steels are quenched and tempered to their maximum strength characteristics.

Consideration, for new units, is being given to a new series of low-alloy steels containing vanadium in conjunction with chromium, nickel and molybdenum. It is estimated that with this series of steels it will be possible to approach the 300,000 psi. ultimate strength predicted for the new stainless steels.

Since there is no cooling system included in a solid propellant unit, severe heating conditions occur in the nozzle entrance and throat sections.

The reactant gases are not only extremely hot, they are also very erosive and will tend to eat their way into exposed metal surfaces. This is especially true for the long burning time motors using new high-performance propellants.

Various types of insulators are provided to protect the nozzle section metal from overheating. The highest rate of heat transfer occurs at the nozzle throat and it is usually necessary to use a graphite insert (backed up with an insulator) to avoid excessive erosion. The excellent thermal diffusivity of the graphite, as well as its high deterioration temperature (6,000 F.), makes it an excellent material for use in the nozzle throat section.

Extensive programs have been conducted in an effort to perfect other suitable materials, such as ceramic and plastic type materials, but none of the tested materials have performed as well as graphite. Ceramics have low strength, are brittle and susceptible to thermal shock.

Plastic Throat in Use

Heating conditions to which the nozzle exit section is subjected are far less severe than those in the throat section. It has been possible to achieve excellent performance characteristics with fiberglass or asbestos-reinforced resin molded exit cones. Since these materials have a density of less than one-fourth that of steel, they result in considerable cost savings.

These materials are very poor conductors of heat. The exposed surfaces tend to carbonize, forming a protective layer, and erode away a layer at a time.

A typical solid propellant insulator consists of a phenolic-resin glass-cloth material directly bonded to the metal as a laminated product. This resin will carbonize on the surface when exposed to 600 F. But the structure will remain essentially intact when exposed for short periods of time (6 min.) to highly erosive gases at temperatures as high as 4,500 F.

Recent developments indicate that even superior performance characteristics are obtainable with a silica-fibered phenolic-resin material.

Jet Vane Problems

It is common practice in conventional missile applications to direct the rocket motor line of thrust through the center of gravity of the assembled missile. To maneuver the missile during powered flight, line of thrust of the rocket motor is deflected imparting a turning moment to the complete system. In some units the rocket motor is mounted on a gimbaled support which will allow it to be pivoted relative to the remainder of the missile. In another system vanes are mounted in the path of the exiting rocket motor gases. By movement of the vanes it is possible to deflect the gases and alter direction of the line of thrust.

Until recently graphite was used as the vane material because of its

excellent erosion-resistant characteristics and high temperature of deterioration. There is a great disadvantage in the use of graphite—it tends to crack and break easily. This is especially bad in the vane application where it is not backed up with a metal supporting structure. An extensive developmental program was conducted to determine suitable alternate materials.

As a result of this program, one of the current large missiles is using high pressure molded glass-phenolic jet vanes in place of graphite.

In the original design of this unit graphite vanes were equipped with molybdenum leading edges to reduce gas erosion to a minimum. The glass-phenolic molded vanes proved to be approximately 25% superior to the molybdenum tipped graphite vanes on the basis of erosion that occurred during motor operation.

Actually, the use of molybdenum leading edges on the plastic type molded vanes proved to be of little value. When the molybdenum is used with graphite, the heat picked up by the moly is readily transmitted away from the heat source because of the excellent thermal conductivity characteristics of graphite. This does not occur with the plastic vane. It is a relatively poor conductor of heat and the moly tip merely functions as a heat well. In a very short period of time the moly is heated to a point where it deteriorates and is eroded away by the high velocity, exiting products of combustion.

Mechanism of erosion for the plastic-type vane is similar to that of the plastic insulators. The organic binder tends to carbonize and this allows the fibers to erode away. Since these materials are very poor conductors of heat, the failure occurs essentially a layer at a time. After operation the inner sections of the vane will exhibit their original texture and color, demonstrating that they were not overheated during use.

Better Materials Coming

The various material developmental programs are directing their efforts toward the improvement of missile performance characteristics.

Stainless steels have shown marked improvements, both from a standpoint of higher strength and higher heat resistant characteristics. Similar programs are being conducted to improve properties of aluminum, titanium and low-alloy steels. In addition, major efforts are being conducted towards the perfection of new ceramics, oxide coatings and cermets to get new high-temperature resistant materials that can withstand the erosion and high temperatures of new solid propellant systems.

Because of the high strength-density ratio obtainable with the resin impregnated glass filament wound structures, considerable attention has been focused upon them.

Under idealized conditions, when all of the glass filaments are aligned in the direction of the applied load, a tensile strength of 180,000 psi. is possible. If filaments are peripherally wound on a cylindrical vessel and this vessel is subjected to hoop tensile stresses only, it is possible to realize burst strength values as high as 180,000 psi. These data indicate that if the glass filaments are aligned in the direction of the principal stress in a closed-end pressure vessel, where both hoop and longitudinal stresses are applied to the structure, hoop tensile strengths in excess of 100,000 psi. should be realized. Unfortunately with current methods of fabrication it has not been possible to achieve hoop burst tensile strengths in excess of 75,000 psi.; and this value is obtainable only in specially constructed closed-end vessels. The full hoop strength characteristics of the glass filaments are usually not realized in closed-end pressure vessels because of the bending loads applied to the structure in the vicinity of the end closure joints.

With current available resin materials, it is possible to realize flexural strengths as high as 90,000 psi. with an accompanying ultimate tensile strength of 75,000 psi. This considers the use of a resin impregnated glass cloth material which must be hand laid-up a layer at a time, making the part highly expensive and not conducive to quantity production. For production, the part would be high-pressure molded in matched metal dies, using a chopped glass fiber, impregnated with a high-temperature resistant resin. Unfortunately, a part molded in this manner will exhibit low structural characteristics, having an ultimate tensile strength of less than 12,000 psi.

Developmental programs are under way where a combination glass cloth, chopped fiber structure is fabricated by high-pressure molding techniques. It is proposed that glass cloth preforms be used during the molding operation, with the glass cloth located in the areas subjected to high stress conditions.

Reliability Is Foremost

Although the efficiency of a rocket motor is of great importance, its reliability of operation is more important. All design concepts must consider reliability as foremost above all other considerations.

A missile may sit on a launching ramp for five years prior to use, but even after this long period of storage it is expected that the unit will perform in accordance with its established standards when the range officer pushes the fire button. For a liquid unit, this means that the myriad of mechanisms, control valves, gas generators, turbines, pumps, injectors, etc., will all perform as they were originally designed to do.

A good example of the problems that have been coped with are those associated with liquid oxygen.

Although the missile must be ready for launching within a few minutes notice, it is impractical to store liquid oxygen in the missile tanks for any long periods of time. For most large missiles, this storage period cannot exceed approximately eight hours; otherwise the control valves and associated mechanisms become frozen.

When it becomes necessary to fire the missile, tons of propellant must be loaded into the missile, and this must be accomplished as rapidly as is feasible. However, the propellant loading equipment cannot start off by ramming the liquid into the missile tanks at full pressure, for the resulting stresses would be disastrous to the tanks and their accompanying plumbing fixtures. The inflow of the propellants has to be programmed to begin at a slow rate until the lines are full, then the rate of flow can be increased. When each tank is nearly full, the pressure must be reduced to avoid rupturing the tank structure.

The liquid oxygen problems are merely typical of the type that are being solved. This work is undoubtedly establishing our standards for the future.

TABLE 2 Important U.S. Missiles

	General			Status			Powerplant				Guidance	Performance	
	Missile Name	Service	Prime Contractor	Research	Develop.	Production	Service use	Manufacturer	No. of Engines	Rated Thrust (lb.)	Guidance Type	Max. Mach. No.	Max. Range (mi.)
Air-to-Air	Diamondback	BuOrd	Philco								Infrared		
	Falcon	USAF	Hughes				•	Thiokol (solid)	1		Radar hom'g		
	Genie	USAF	Douglas				•	Aerojet (solid)	1		Unguided		1.5
	Sidewinder	BuOrd	Philco/GE				•	(solid)	1		Infrared		2.0
	Sparrow 1	BuAer	Sperry				•	Aerojet (solid)	1		Beam rider	2.5	
	Sparrow 3	BuAer	Raytheon			•		Aerojet (solid)	1		Radar hom'g	2.5	
	Zuni	Navy				•					Unguided	3.0	
Air-to-Surface	Bullpup	Navy	Martin			•		Aerojet	1		Command		
	Corvus		Temco	•	•			RMI					
	Hounddog	USAF	North Amer.		•			Pratt. & Whit.					
	Green Quail	USAF	McDonnell	•	•			GE					
	Crossbow		Northrop		•								
	Rascal	USAF	Bell			•		Bell	3	12,000	Radar c'and	1.5	100
	Wagtail	USAF	Minn.-Hwell								Inertial		
Anti-Submarine	Astor												
	Asroc		Minn.-Hwell										
	Subroc												
	Petrel	BuOrd	F'child				•	F'child	1	1,000	Radar hom'g	0.7	
	Rat	Navy	Naval Ord			•		A'gany B'tic	1		Acoustical		
Surface-to-Air	Bull Goose	USAF	F'child		•	•		F'child	1				
	Bomarc	USAF	Boeing		•	•		Marquardt[e]	2	10,000	Gr. control/ radar hom'g	2.5	200
	Hawk I	ArmyOrd	Raytheon		•	•		Aerojet (solid)	1		Radar hom'g		22
	Nike-Ajax	ArmyOrd	WeEl		•	•	•	Gov't (liquid)	1	2,600	Command		25
	Nike-Hercules	ArmyOrd	WeEl		•	•		Gov't (solid)	1		Command		
	Nike-Zeus	ArmyOrd	WeEl	•	•			Gr. Central			Command		
	Talos	BuOrd	Bendix			•		Bendix[e]	1		Beam rider/ passive hom'g	2.1	25
	Tartar	BuOrd	Convair		•	•			1				10
	Terrier 1	BuOrd	Convair			•	•	M. W. Kellogg (solid)	1		Beam rider	2.5	10
	Terrier 2	BuOrd	Convair			•	•		1		Beam rider	2.5	20
Surface-to-Surface	Atlas	USAF	Convair		•	•		North Amer. (LOX)	1	135,000	Radar command	20.0	5,500
	Corporal	ArmyOrd	Gilfillan/ Firestone			•	•	Ryan (liquid)	1		Command		100
	Dart	ArmyOrd	ADC[a]			•		Gr. Central (solid)	1		Optical		
	Honest John	ArmyOrd	Douglas			•	•	Hercules	1		Unguided		15
	Jupiter	ArmyOrd	Chrysler			•		North Amer. (liquid)	1	135,000	Inertial	12.0	1,500
	Lacrosse	ArmyOrd	Martin			•		Thiokol (solid)	1		Command		8
	Little John	ArmyOrd	Emerson		•	•		Hercules	1		Unguided		
	Mace	USAF	Martin			•		Allison[d]	1	3,700	Inertial	0.9	650
	Matador	USAF	Martin				•	Allison[d]	1	3,700	Radar	0.9	
	Pershing	ArmyOrd	ABMA[b]	•	•				1				
	Polaris	Navy	Lockheed	•	•			Aerojet (solid)			Inertial		1,500
	Redstone	ArmyOrd	Chrysler		•			North Amer. (LOX)	1	75,000	Inertial		200
	Regulus 1	BuAer	Ch.Vought				•	Allison[d]	1	4,600	Command	0.9	500
	Regulus 2	BuAer	Ch.Vought		•	•		GE[d]	1	10,000	Command or inertial	2.0	1,000
	Sargeant	ArmyOrd	JPL/Sperry[c]		•	•		Thiokol (solid)	1		Inertial		200
	Snark	USAF	Northrup		•	•	•	Pratt & Whit.[d]	1	11,000	Stell. iner.	0.9	5,000
	Thor	USAF	Douglas		•	•		North Amer. (liquid)	1	165,000	Inertial		1,500
	Titan	USAF	Martin	•	•			Aerojet (LOX)	3		Inertial	20.0	5,500

a. Aerophysics Develop. Corp. b. Army Ballistic Missile Agency. c. Jet Propulsion Lab. d. Turbojet, solid booster. e. Ramjet, solid booster.

Source: Aviation Wk.

SPECIAL REPORT

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RED fuming nitric acid sampling at Cape Canaveral.

III. Search for More Powerful Missile Fuels

The trend is toward easy-to-handle solid fuels, although liquids can't be counted out. Recent work promises to boost "push" of solids.

During the past 10 years a tremendous amount of progress has occurred in the formulation of new high-performance solid and liquid propellants. For example, during World War II all of the rockets produced by the United States used a solid nitroglycerin-nitrocellulose double base propellant commonly referred to as ballistite. The basic composition of this propellant is essentially the same as that used in trench mortars.

Production Advances in Solids

Prior to World War II the nitrocellulose, nitroglycerin and other additives were mixed in a sigma-blade mixer in the presence of solvents, such as alcohol or acetone, to the consistency of a stiff dough. This material was then extruded to the desired shape in conventional ram presses and the excess solvent removed by evaporation.

At the beginning of World War II, great interest developed in the rocket as a weapon, and attention was focused upon the familiar double-base materials for the propulsion system. However, in going from guns to rockets, burning times changed from milliseconds to seconds, and propellant grain thicknesses became much greater. Time required for the release of the processing solvent for the thick grains became too long to be tolerable. A solventless method for processing the propellant was then perfected which consists of colloiding or plasticizing the nitrocellulose by subjecting it to hot working on rolls. Final grain configuration is obtained by a hot extrusion operation performed on the plasticized nitrocellulose.

By the end of the war we were producing approximately 20 million lb./mo. of solventless propellant for rocket use.

Since the end of the war long range rockets have required still larger propellant grains with thicker web sections. These new requirements exceeded the capacity of equipment available to extrude propellant grains. This led to the production of grains by casting, in which the ingredients are incorporated in a mold or container having the shape and dimensions of the required propellant grain. Methods were devised for producing satisfactory double base and composite type propellants.

Composite Propellants Popular

With the exception of Hercules Powder Co. and some of the Government agencies who are concentrating on double-base type propellants, the greater part of solid propellant effort has now been placed in the field of composite type propellants.

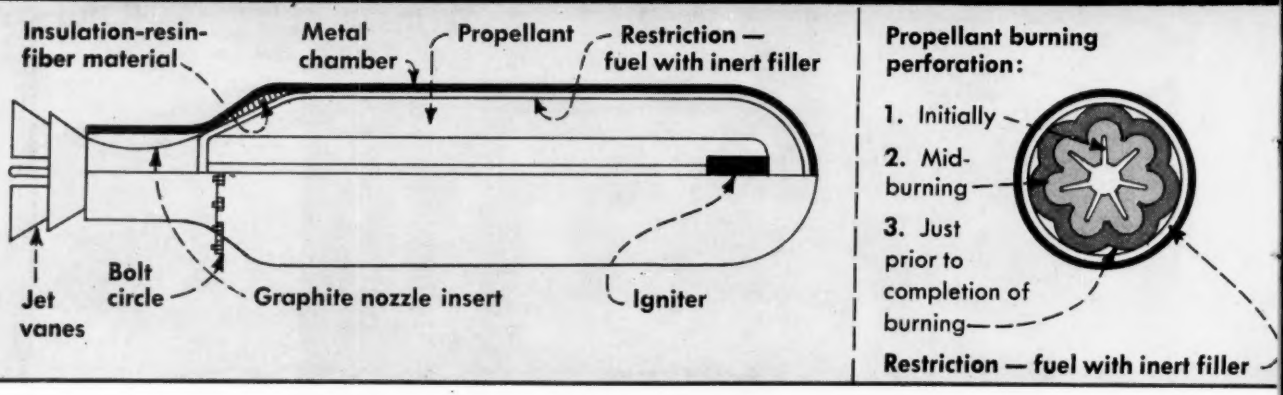
A typical composite propellant is one that uses an organic resin as the fuel and binder with a solid oxidant, such as ammonium nitrate. Typical solid oxidants in solid propellants are shown in Table 3. The various types of fuel-binders are summarized in Table 4.

Solid propellant development programs have placed emphasis on cost, aging stability, satisfactory physical characteristics and specific impulse. For example, immediately following World War II propellant development programs were directed towards achieving superior aging characteristics and lower cost propellants.

Although the double-base propellants are quite stable, some difficulties were encountered during the war because of the continual migration of nitroglycerin fumes from the propellant. This was especially serious where it was necessary to store the loaded rocket motors in relatively high-temperature environments. All problems relating to aging characteristics were resolved with the introduction of composite type propellants, since the majority of these propellants have essentially unlimited aging characteristics.

To achieve low-cost propellants, ammonium nitrate and potassium perchlorate were used as oxidizers.

FIG. 3 **Simplicity Is Feature of Solid Propellant Rocket Motor**



The original composite propellant, developed by Aerojet, employed potassium perchlorate as the oxidizer and modified polyester resin as fuel. This propellant, is characterized during firing by plumes of white smoke.

Potassium perchlorate exhibits excellent aging, reliability and reproducibility performance characteristics. It formed the basis for future composite propellants.

It is customary to purchase the oxidant, such as potassium perchlorate, in a relatively large grain size and then process it through a grinding operation, or series of grinding operations, at the propellant plant to maintain very exacting control over particle size. The particle size of the oxidant, as well as the chemical constituents in the fuel, have a very definite effect upon the propellant ballistic characteristics.

Upping Solid Impulse

The propellants utilizing potassium perchlorate or ammonium nitrate as the oxidizer exhibit relatively low specific impulse characteristics, ranging from 180 to 195 for the former and 185 to 210 lb.-sec./lb. for the latter type propellants.

When it became necessary for the solid propellants to become more competitive with high specific impulse liquid propellant units, emphasis was placed on the use of ammonium perchlorate as an oxidizer. By almost a direct substitution of this material for potassium perchlorate it is possible to increase the specific impulse to approximately 210 to 225 lb.-sec./lb.

Efforts are now being made, under various classified projects, to obtain solid propellant specific impulses in excess of 250. Some companies claim they have successfully achieved this.

Designing Propellant Charge

Usually the solid rocket motor design engineer will be given certain missile design requirements. These might include maximum allowable weight of the rocket motor, allowable external dimensions, as well as thrust and burning time requirements.

The designer must select a propellant formulation and work out the geometric grain configurations to meet operating specifications.

The final propellant grain design can vary from a simple end-burning cigarette type, to an internal burning grain having a complex, intricately shaped perforation. A common perforation, used in many units, is the star configuration, shown in Fig. 3.

As we discussed before, this grain is usually coated on the outer surface with a liner which inhibits burning. Thus the grain burns from the inside surface to the outside surface.

Grain Design Factors

Thrust of a solid rocket motor is a direct function of the propellant burning area. If a constant thrust is required throughout complete operation, the propellant burning area must not vary greatly. The engineer must design his propellant charge so that its burning surface area remains nearly constant at each increment of burning. This is not easily achieved when it is realized that the cross-sectional area of the initial perforation is very small compared to the cross-sectional area at propellant burn-out.

Initial perforation cross-sectional area is also critical. It establishes the loading density of the propellant or the weight of propellant per unit length. An attempt is made to make it as small as feasible and still comply with design requirements. However, in no instance is it made less than the area of the nozzle throat; otherwise flow of the products of combustion becomes so restricted that a malfunction will occur.

With some propellants it is necessary that the initial perforation area be at least twice that of the throat area to avoid a malfunction.

In designing the propellant charge it is also important to consider burning duration. For a star-shaped perforation the burning duration is usually established by the thickness between the star point and the outside diameter of the charge. This distance is referred to as the web thickness.

When an engineer sets out to design a propellant charge, he must consider all these factors: allowable weight, external dimensions, propellant burning area, initial perforation area and web thickness.

Solid Physical Problems

Aside from the burning characteristics, propellant grains must have certain physical properties. They must withstand handling conditions prior to firing, as well as the loads to which the grain is subjected during the actual firing operation.

Prior to development of the internal burning grain, malfunctions were encountered as a result of propellant grain fracture. This was caused by differential pressures between the fore and aft ends of the grain (differential pressures

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cause grain column buckling). Development of the internal burning grain, which is supported throughout its length by the chamber walls, decreased this type of failure. However, increased strength characteristics of the propellants has been and still is a great challenge. Propellant cracking or rupture will ultimately result in a malfunction or complete "blowup" of the rocket motor.

The operating pressure of the unit is a function of propellant burning area and nozzle throat area, with increases in burning area for most propellants resulting in marked increases in operating pressures. To avoid propellant cracking, the propellant chemists are using flexible fuel-resins, such as the polysulfides, polyvinyls and polyurethanes.

In the majority of Armed Services applications it is required that the rocket motor be capable of sustaining various types of environments. For example, it must be capable of satisfactorily withstanding rough handling characteristics encountered during shipping and in actual combat operations. Also, it is required that the unit be capable of standing temperatures between extremes such as —65 to +165 F.

The majority of flexible propellants have a temperature coefficient of expansion in the order of 30×10^6 in./in./F. as compared to 6.8×10^6 for steel. Provisions must be made in the design of these units

TABLE 3 Oxidants Are Key to Good Solid Propellant Performance

Material	Available Oxygen, %	Anticipated Specific Impulse, Lb.-Sec./Lb.	Exhaust, Exclusive of Oxygen Compounds	Cost, $/Lb.	Total U.S. Prod. In 1956, Tons	% Used in U.S. Rockets In 1956
Ammonium nitrate	19.5	Under 200	Nitrogen	0.05 to 0.10	1×10^6	0.5
Ammonium perchlorate	34.2	Over 200	Nitrogen & hydrogen chloride	0.50 to 0.75	3,600	80.0
Nitrocellulose		Under 200	Carbon, hydrogen, oxygen & nitrogen	0.70 to 1.00	10,000	10.0
Nitroglycerin		Over 200	Carbon, hydrogen, oxygen & nitrogen		2,000	50.0
Potassium perchlorate	46.2	Under 200	Potassium chloride	0.15	1,000	25.0

TABLE 4 Plastics Act as Both Fuel and Binder in Solid Propellants

Material	Fuel Value	Processing Method	Physical Characteristics	Availability	Exhaust Products
Acrylic	Moderate	Cast	Brittle	Moderate	C,H,O
Cellulose	Excellent	Cast extrusion	Flexible	Excellent	C,H,O
Epoxy	Fair	Cast	Brittle-flexible	Poor	C,H,O
Phenolic	Fair	Cast	Brittle-flexible	Excellent	C,H,O,N
Polyamide	Fair	Cast extrusion	Flexible	Excellent	C,H,O,N
Polyester	Fair	Cast	Brittle-flexible	Excellent	C,H,O
Polyethylene	Moderate	Cast extrusion	Flexible	Excellent	C,H,O
Polysulfide	Moderate	Cast	Flexible	Poor-mod	C,H,O,S
Polyurethane	Moderate	Cast	Flexible	Poor-mod	C,H,O
Polyvinyl	Fair	Cast	Flexible	Excellent	C,H,O
Synthetic rubber	Poor-fair	Extrusion	Flexible	Excellent	N,O,S,H

TABLE 5 Keys to Liquid Propellant Performance (500 Psia.)

Oxidizer	Fuel	Specific Impulse Lb.-Sec./Lb.	Combustion Temperature, F.	Molecular Wgt., Products of Combustion	Ratio of Specific Heats
Red fuming nitric acid (22% NO_2)	Aniline	235	5100		
	Ammonia	237	4220	21	1.24
	JP-4 gasoline	240	5150	25	1.23
	Unsymmetrical dimethyl hydrazine	250	5200	22	1.23
Hydrogen peroxide (99%)	Ethyl alcohol	240	4600	23	1.24
	Hydrazine	262	4690	19	1.22
	JP-4 gasoline	248	4830	21	1.20
Liquid oxygen	75% Ethyl alcohol	247	5150	23	1.22
	Methyl alcohol	251	5230	22	1.21
	Isopropyl alcohol	259	5560	22	1.22
	JP-4 gasoline	264	5770	22	1.24
	Hydrazine	280	5370	18	1.25
	Hydrogen	364	4500	9	1.26
Liquid fluorine	JP-4 gasoline	280	7100	24	1.22
	Ammonia	306	7224	19	1.33
	Diborane	310			
	Hydrazine	316	7940	19	1.33
	Hydrogen	373	5100	8.9	1.33

to adequately compensate for the large chamber-propellant differential movement that occurs during the temperature cycling operation. It is for this reason that the majority of propellant formulations cannot be bonded directly to the chamber walls, even though this bonding operation lends great structural support to the propellant during handling and firing.

Few Solid Failures

The operational difficulties for the solid propellant rocket motors have been fairly well resolved as a result of research and development programs, aided by constant static and dynamic firing tests. These programs are obviously costly, but are certainly warranted when it is possible to obtain units whose operational characteristics are well defined. For example, the solid JATO rocket motors have achieved an enviable reliability record: a failure of less than five in one million.

The average solid propellant artillery rocket has a reliability of 99.995%. This is especially interesting when it is realized that the liquid propellant experts have aspirations of achieving a reliability of 98% in the next 10 years for liquid motors.

Liquid Motors Declining?

The simplest type of liquid rocket motor design uses pressurized inert gas as a means of forcing the liquids into the combustion chamber.

Inert gas pressure is regulated to maintain a constant pressure-drop between each liquid and the combustion chamber. Since at the end of operation the fuel and oxidizer tanks are filled with the inert gas, initial gas pressure is somewhat higher than the actual operating pressure of the motor. For large rocket motors size and weight of the inert gas container becomes prohibitive and you must then resort to a pumping system to inject liquids into the combustion chamber of the rocket.

With a pumping system it is necessary to use an auxiliary power plant for starting the pumps (Fig. 2). For example, the German V-2 unit made use of a hydrogen peroxide steam generating power plant to drive a steam turbine unit directly connected to the fuel and oxidizer pumps.

There are a multitude of problems associated with pump discharge rates in excess of a 1,000 gal./min. These are high-speed rotary pumps that should be at operating speeds with essentially zero time lag. Also, the liquid being pumped is red fuming nitric acid or liquid oxygen, two typical liquid propellant oxidizers.

Regardless of the size of the unit the oxidizer and fuel are eventually conveyed to the injector plate, which consists of a multitude of small holes through which the two liquids flow. The holes are commonly oriented so the oxidizer and fuel jets will impinge upon each

other for adequate mixing between the fuel and oxidizer. Many of the injector plates look somewhat like a conventional shower head.

Some of our fuel-oxidizer systems are hypergolic, that is spontaneous combustion occurs when the two liquids are mixed together. Red fuming nitric acid and aniline fall into this category. No means of initiating combustion is required in such systems.

If a jet fuel such as JP-4 is used in place of aniline, spontaneous combustion no longer takes place. Then it's necessary to resort to a heat source, such as a glow plug, to initiate burning.

Liquid Cools Chambers

It is a common design practice to use one of the liquids as a coolant for the combustion chamber. This is accomplished with an inner and outer sheet metal skin designed to work together structurally and to allow the coolant to flow between them. Normally the two walls are attached to each other so it is necessary for the coolant to follow a spiral path around the combustion chamber as it works its way towards the injector plate.

Through the accumulation of a large amount of empirical data it's now possible for the rocket engineer to design a cooling system which avoids overheating of the combustion chamber, and at the same time maintains the coolant at a temperature below its point of vaporization. Burn-outs of the combustion chamber are prevented and the coolant liquid is preheated, which tends to improve the efficiency of the rocket motor.

Lots of Liquid Data

Information is limited on the solid fuel-oxidizer systems. But there is a multitude of data available regarding the liquid propellant systems.

Performance data for various liquid propellant systems are summarized in Table 5. These data are based upon a rocket motor operating at 500 psia. under optimum operating conditions. The combustion products are assumed to be at chamber temperature conditions. If these oxidizer-fuel systems were to operate at 1,000 psia. in place of 500 psia. an increase in specific impulse of approximately 7% would occur. This increase is primarily a function of the thermodynamic efficiency of the expansion process. Also, the higher chamber pressure tends to suppress the dissociation of some of the exhaust products, resulting in a greater kinetic temperature.

Propellant combinations involving the nitric acid and hydrogen peroxide oxidizers are in the general order of 240 to 250 sec. of specific impulse; combinations involving liquid oxygen show somewhat higher values, approximating 265 sec.

When liquid fluorine is used as the oxidizer, an increase of approximately 20% in specific impulse is obtained, compared with liquid oxygen. It is for this reason that a large amount of research and development work is being directed towards the application of liquid fluorine.

Referring back to Eq. 3, note that specific impulse can be increased by reducing the molecular weight of the products of combustion. Table 5 indicates that the majority of the systems exhibit a molecular weight of the order of 20.

If a reduction in the molecular weight is to be achieved, the high molecular weight constituents must be eliminated or reduced in magnitude, accompanied by an increase in concentration of the low molecular weight constituents.

Table 6 summarizes typical products of combustion formed during rocket operation. These molecular weights vary from a low of 1 for the hydrogen atom to a high of 69 for the combined carbon-fluorine molecule of CF_3.

Keep Molecular Weights Low

Table 6 demonstrates that the molecules formed with the carbon, nitrogen and fluorine atoms should be kept to a minimum. Emphasis should be placed on the formation of molecules that incorporate the maximum amount of hydrogen.

The absolute minimum molecular weight of combustion products would have a value of 1.5 to 2, assuming there is a high concentration of hydrogen atoms in the products of combustion. This is the lowest possible molecular weight which can ever appear in the specific impulse equation. A realizable value of 8.9 is obtained with the fluorine-hydrogen system.

Visionary power plants, which derive their energy from nuclear fission or free radical recombustion, are not included in this discussion. The problem of achieving a low molecular weight suggests that the propellant scientists concentrate their efforts towards the use of elements in the first two periods of the periodic table, hydrogen through neon. It is for this reason that there has been so much fanfare about the use of lithium, beryllium, boron in rocket motor propellant systems. The respective atomic weights for those elements are 6.94, 9.01 and 10.82 as compared with 12.01, 16.00 and 19.00 respectively for carbon, oxygen and fluorine.

Keep Temperatures High

The combustion temperature of a rocket motor is a measure of gas energy available during isentropic expansion in the rocket nozzle.

Table 6

Combustion Products From Rocket Motors

	Molecular Weight
H	1.01
H_2	2.02
C	12.01
N	14.01
O	16.00
OH	17.01
H_2O	18.02
F	19.00
HF	20.01
CO	28.01
N_2	28.02
NO	30.01
CF	31.01
O_2	32.00
F_2	38.00
CO_2	44.01
CF_2	50.01
C_2F_2	62.02
COF_2	66.01
CF_3	69.01

Energy generated during the rocket combustion reaction is derived from the breaking of chemical valence bonds in the fuel and oxidizer molecules and the forming of new and normally stronger bonds in the gaseous products of reaction.

In selecting propellant systems that will yield high combustion temperatures, attention is focused upon compounds that are formed from low energy chemical bonds which will, upon combination, lead to products which have high bond energies. From Table 5 note that the lowest flame temperature of 4,220F. is obtainable with the nitric acid-ammonia system, whereas a flame temperature of 7,940F. is derived from the fluorine-hydrazine propellant combination. This high order combustion temperature is the result of the breaking of the weak F-F bonds and the forming of stronger H-F and N-N bonds. The acid-ammonia low flame temperature is primarily a result of lower order bond energies.

In some instances the low flame temperatures are a result of advanced dissociation of some of the reactant products, notably H_2O and CO_2. For example, the low temperatures of the alcohol-oxygen systems are in part a result of the combustion gases containing large quantities of H_2O or H_2O constituents. Dissociation of water initiates at relatively low temperatures, 5% being dissociated at 5,000F. Thus, a part of the reaction energy is not realized because of the energy-expensive dissociation of H_2O and other constituents.

Almost all of the available reaction products in current rocket motors begin dissociating at approximately 5,000F. and reach advanced dissociation levels at 9,000F. Thus, combustion temperature is limited by the dissociation of the reaction products.

Liquid Chemical Problems

Since weak bond energies are associated with high gas temperatures and low molecular weights, chemical problems arise as a result of more reactive compounds, more unstable compounds and, generally, more toxic compounds. For example, liquid oxygen is far superior as an oxidizer compared to nitric acid, but liquid oxygen must be maintained at a temperature below its boiling point of −360F. It is not possible to store liquid oxygen within the rocket motor for long periods of time as with the acid.

A similar problem results when an attempt is made to use liquid hydrogen, since its boiling point is −423F.

Hydrazine (N_2H_4) is a high energy fuel when compared to gasoline but it is also more unstable, more reactive and more toxic.

Liquid fluorine, which must be maintained below −367F., is undoubtedly the best oxidizer currently available to the rocket engineer, but prior to its being put into use, many problems must be overcome. For example, fluorine exists in nature primarily in one form, very solidly chained to a calcium atom. This link must be broken—first chemically and then electrically—prior to using fluorine for rocket combustion.

In addition to presenting many handling problems, the rocket exhaust products with fluorine compounds also may prove troublesome. A pound of fluorine will produce approximately one pound of hydrogen fluoride when used with a hydrogen-containing fuel. Hydrogen fluoride is a very corrosive and toxic product.

Better Specific Impulses

Current liquid propellant rocket motors are achieving specific impulses as high as 264 lb.-sec. per lb. through use of the liquid oxygen-gasoline system. Up until just recently the best solid propellant system did not yield a specific impulse in excess of 230 and although it has not been verified, it is now assumed that the solid propellant systems are approaching the 260 specific impulse value.

The relatively low specific impulse of the solid units has been one of the big reasons why liquid units are used even though their reliability is so far inferior to solid propellant units. For example, the drag-free velocity of a rocket propelled missile is a direct function of specific impulse as shown in the following equation:

$$V = I_{sp}\, g \ln (W_i/W_f) \qquad (4)$$

where

V = burn-out velocity, fps.
I_{sp} = specific impulse of propellant, sec.
g = 32.2 ft./sec.^{2}
W_i = initial weight of missile, lb.
W_f = weight of missile after propellant consumption, lb.

This Eq. (4) is presented to demonstrate the importance of specific impulse in a complete missile system.

It has only been within the last two years that serious consideration was given to use of solid propellants in large motors such as the IRBM and ICBM missiles. Many rocket scientists believed that it was impractical to mix, cast and cure large solid propellant rocket motors. This is not the case. Actually, the solid propellant engineer has the opportunity to mix oxidizer and fuel together under carefully controlled conditions. He is not forced to accomplish this in an extremely short period of time as is necessary in the liquid propellant motor. In fact, after the solid propellant grain has been produced, engineers have ample opportunity to determine the quality of their product through various testing devices.

Why Low Ready-Time?

Ready-time is a very important factor in current missile applications. Ready-time is the time interval between the decision to fire a missile and the instant it is actually launched. It is obvious that this interval should be as small as practicable.

It is customary to classify propellant systems as solid, storable liquid and non-storable liquid. The ready-time varies from almost zero for missiles using solid propellants to some nominal value for missiles using non-storable liquid propellants, with the storable liquids in an intermediate position.

The ICBM's using a liquid oxygen system require hours for their ready-time and under the very best of conditions engineers hope to reduce this to about one-half hr. Since the 5,000-mile flight time for an ICBM is estimated to be approximately one-half hr., it appears logical that the ready-time for an effective ICBM weapon system would be less than this. This is especially true for anti-missile missiles, since otherwise they would be completely ineffective.

How to Control Thrust

After the missile has been fired, other factors become dominant.

The problem of thrust control during operation has always plagued the solid propellant rocket engineers. Once the mechanism of

burning has been initiated it is almost impossible to stop or throttle the burning of the propellant. In a liquid system it is possible to control the thrust and to turn the motor on and off by appropriate use of the various flow control devices inherent in the system. Some means of control of the operation is especially required in ballistic missile applications, since these units are guided on course only during the first phase of flight when their rocket motors are in operation.

To pin-point a target, it is necessary to program flight of the missile during rocket motor operation, with the rocket motors cut-off at the proper instant so the missile will free-flight into the target area. For example, the ICBM Atlas is designed to carry a full-size H-bomb 800 mi. up into the stratosphere at which time its flight course will be altered to point the missile in the direction of the target. At a predetermined speed the motors are to be cut-off and the missile will free-flight its way to the target. Control of operation of the rocket motors plays an important part in the guidance system of ballistic missiles.

It will be necessary to control the thrust of solid units by grain geometry or missile design before solid propellants can be effectively used in ballistic missile applications. Inasmuch as the Navy is pioneering use of a solid system in the IRBM Polaris, we can assume that the solid propellant people have succeeded in developing thrust control mechanisms, at least within certain limitations.

Solid units are now a serious contender to the liquid systems in long-range missile applications.

Why All the Missiles?

Table 2 summarizes some of the salient characteristics of current U. S. missiles either in production or in the final stages of development.

Until the ICBM's came into prominence in the summer of 1957, the Nike Ajax was undoubtedly the most publicized missile in the world. It represented a typical missile system consisting of an explosive warhead, a guidance unit and a liquid rocket sustainer motor and a solid propellant booster unit.

When the missile is launched the initial seconds of flight straight up are powered by the solid propellant booster motor, which disengages the missile upon completion of its burning. The sustainer rocket then takes over and the second stage of flight begins, at which time the missile turns and heads for the target at supersonic velocity.

The Nike control equipment, classified as a beam rider, consists of three radars, an electronic computer and automatic plotting boards. This

TABLE 7 Who's Working on Fuels & Materials[a]

Fuels and Oxidizers (Suppliers)

Aerojet-General Corp.
AFN, Inc.[b]
Air Products Co.
Allied Chemical & Dye Corp.
American Potash & Chemical Corp.
American Rocket Co.
Astrodyne, Inc.
Atlantic Research Corp.
Becco Division of Food Machinery & Chemical Corp.
Callery Chemical Co.
Columbia-Southern Chemical Co.
Commercial Solvents Corp.
Enjay Co.
Esso Standard Oil Co.
Ethyl Corp.
Fairmount Chemical Co.
Foote Mineral Co.
General Chemical Div. of Allied Chemical & Dye Corp.
Grand Central Rocket Co.
HEF, Inc.[c]
Hercules Powder Co.
Hooker Electrochemical Co.
Linde Co.
Metal Hydrides, Inc.
National Distillers & Chemical Corp.
Olin Mathieson Chemical Corp.
Pennsalt Chemicals Corp.
Phillips Petroleum Co.
Propellex Chemical Corp.
Quaker Oats Co.
Reaction Motors, Inc.
Rocketdyne Division of North American Aviation Corp.
Rohm & Haas Co.
Shell Chemical Corp.
G. Frederick Smith Chemical Co.
Solvay Process Division of Allied Chemical & Dye Corp.
Standard Oil Co. (Ind.)
Stauffer Chemical Corp.
Stauffer-Aerojet Co.
Thiokol Chemical Corp.
Tidewater Oil Co.
Union Carbide Chemicals Co.
Union Oil Co. of California
Westvaco Chlor-Alkali Division of Food Machinery & Chemical Corp.
Wyandotte Chemical Corp.

Materials of Construction (Suppliers)

Aluminum Co. of America
Bram Chemical Co. (Nonferrous)
Brush Beryllium Co.
Carborundum, Inc.
Climax Molybdenum Co.
Continental-Diamond Fibre Co.
Carwin Polymer Products Co.
Dow Chemical Co.
Haveg Industries, Inc.
International Nickel Co.
Kaiser Aluminum & Chemical Corp.
Mallory-Sharon Metals Corp.
Naugatuck Chemical Co.
Norton Co.
Raybestos-Manhattan, Inc.
Reynolds Metals Co.
Rogers Corp. (Plastics)
Thompson Fiberglass Co.
Titanium Metals Corp. of America
Various stainless producers

a. This is by no means a complete list. An attempt was made to list the representative companies in the field.
b. American Potash-Food Machinery-National Distillers.
c. Hooker Electrochemical and Foote Mineral.

represents the combined intelligence that detects approaching enemy aircraft and programs the missile to the location where it will meet the on-coming target. The acquisition radar detects an enemy aircraft and alerts the battery control area. A second radar, termed the target-tracking radar, picks up the aircraft at closer range and feeds the target speed and position information into an electronic computer. The third radar follows the launched missile and also feeds this information into the electronic computer.

Commands to direct the flight are determined by the computer and transmitted to the missile's guidance system. Any evasive action by the target is instantly detected by the target-tracking radar and transmitted to the computer. The computer then re-evaluates the trajectory of the missile to comply with the evasive action of the target.

Other types of guidance include: command guidance, which uses coded signals from the launcher; passive homing, where ground radar illuminates the target and the missile "sees" the reflection (or it may see an infrared reflection); active homing, where the missile is equipped with its own radar; inertial guidance, based on the use of gyroscopes (the direction of the force of gravity is compared with a preset gyro direction); and star guidance, similar to that used by ships.

Many missiles have a combination guidance system. This may include command guidance, until a missile "acquires" the target, when a homing system takes over for terminal guidance.

More Potent Propellants Needed

Military requirements demonstrate that more potent propellant systems are needed to meet the challenge for conquering space. With current types of propellant systems the ultimate in specific impulse appears to be through the use of a hydrogen-fluorine system. This will result in a specific impulse of approximately 373 lb.-sec. per lb.

For an ultra-energy system one immediately gives consideration to tapping the nucleus of the atom. However, when all the facets of a nuclear rocket propulsion system are analyzed it is apparent that a practical system lies in the future (5 yr.). There are dangers such as radioactivity, the exhaust product hazards, and complex chemical and mechanical engineering problems.

Free Radical Propulsion?

It appears feasible that a possible solution to the ultra-propellant problem lies in the use of a free radical system (*Chem. Week*, Oct. 12, 1957). Free radicals are molecular fragments, such as methyl (CH_3) and methynyl (CH), formed when sufficient energy is put into a molecule to rupture one of its bonds.

The energy required to rupture the bond, plus the energy of the original molecule, are contained as internal energy in the free radical. This extra energy is released when the radicals recombine to form the original molecule.

Dissociation of ethane into two methyl radicals requires approximately 80 Kcal./mole, and this same amount of energy is released when two methyl radicals team up to form ethane. At high temperatures the two methyl radicals could collide with sufficient impact to split each other into carbon and hydrogen, resulting in only 64 Kcal./mole being released. Since free-radical propellant systems would operate at high temperatures, it is the dissociation action that is important.

It is proposed that the free radicals be recombined in the rocket motor to yield energy that would be used to heat a working gas. This would result in some super specific impulses (over 400). Unfortunately, to date, no one has succeeded in perfecting a practical system for generating free radicals in the concentrations required for propulsion systems. In addition, free radicals usually have only a fleeting existence, since capturing and freezing them is a problem that has not been completely resolved.

A large amount of free-radical research work is being conducted by the Bureau of Standards, Johns Hopkins, Catholic University, Aerojet-General and Phillips Petroleum.

And Ion Propulsion

The acceleration of ions, and their discharge into space, to provide the push for a rocket is another possible ultra-energy system.

In a fuel system an easily ionized metal, such as sodium, rubidium or cesium, would be maintained in a molten state and pumped into a vaporizing chamber as required. The vapor would pass through a series of hot platinum grids where it would be oxidized. The ions would then be accelerated by going through a magnetic field separation. This gives the rocket its thrust. The Air Force has given a contract to Rocketdyne to study the feasibility of ion propulsion.*

What's in It For You?

Jet propulsion certainly offers a wealth of opportunities to the engineer seeking adventures into the realm of unknowns. This field, after remaining almost dormant for centuries, is finally picking up momentum.

One of the biggest fields of research and development lies in the creation of new propellant systems (particularly for space travel) or the modification of current systems to achieve additional amounts of energy.

Along with the development of the new propellant systems it will be necessary to delve into the many problems associated with the propellant system, such as production procedures, cost, missile base handling equipment, physical and chemical properties of the system and its constituents, etc. These represent only a few of the many problems that lie upon the horizon for chemical engineers working on missiles.

* Ion and free radical propulsion would be used at high altitudes, where a few ounces of thrust would be enough for great speeds.

Reprints of This Report for Your Files

If you want to obtain reprints of this 16-page Report on rockets and missiles, they will be available at 75¢ per copy. For fast service use the Reader Service postcard located in the back section of this issue. Ask for Reprint No. 119.

Let Photography Speed Your Drafting

For better presentation at lower cost, combine field photography with conventional drafting techniques to produce photodrawings.

G. P. HAMMOND, and R. C. KINSTLER, The Procter & Gamble Co., Cincinnati, Ohio*

Communicating the design intent from the engineer to the craftsman is a growing problem as our technology becomes more complex and competition becomes stronger. To design new facilities in a minimum time and at the lowest total cost, all engineers must constantly review their practices.

At The Procter & Gamble Co., the search for a better method of communication led us first into engineering models and then into photography. Both techniques are effective because of their three-dimensional aspect.

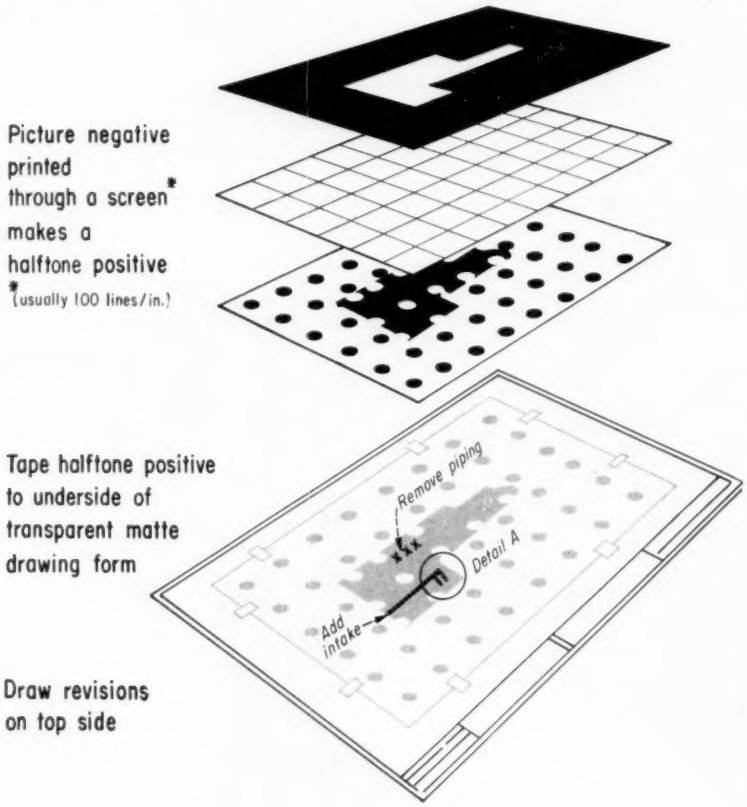
Although modeling is effective on new facilities, it is not practical for revisions to existing facilities. Photography by recording every detail of the existing installation provides an excellent base on which to show engineering revisions and additions.

Before our use of photography, it was a tedious and expensive chore to make changes and additions to existing facilities. The reasons are: (1) a facility is never quite installed according to the drawings and (2) operating personnel normally make revisions which are not recorded on the original drawings.

Therefore, it is necessary to go to the site with engineers and designers to check the installation and to correct the existing drawings before starting new design work. Also, in many cases there are no existing drawings. As a result it is necessary to make field drawings to obtain a base to work from.

*Meet your authors, p. 199 and p. 200.

How to Make a Photodrawing


Picture negative printed through a screen* makes a halftone positive
*(usually 100 lines/in.)
Tape halftone positive to underside of transparent matte drawing form
Draw revisions on top side
Remove piping
Detail A
Add intake

Diazo prints can be made of finished job

How to Use Photodrawings

Most of this field work can be reduced or eliminated by substituting photodrawings for conventional drawings. Photodrawings have two major advantages. First, there is a cost savings in reduced engineering time. Second, there is a construction savings because of the better presentation to the field force.

A properly oriented perspective photodrawing is far easier for the craftsman to understand than is a conventional set of plans and elevations.

The first and still primary application of photography to engineering is in the field of piping. This application is evident when we consider that piping is a large segment of the work in the chemical process industries. However, as the technique developed more applications have been found.

In addition to piping, photodrawing is used for site clearance plans, electrical design including equipment, conduit and wiring installations. Photodrawings are also useful in design of structural and architectural modifications to existing facilities and in the design of additions or alterations to mechanical equipment such as conveyors.

Further uses are in portraying lubrication and maintenance information and producing record drawings of existing objects.

Development of suitable reproducibles to use as a drawing base was necessary before photodrawings became useful on a large scale. Our first attempts utilized conventional glossy prints over which vellum overlays were placed. The necessary drawing work was done on these overlays. There were several intermediate developments before we finally achieved the technique used today.

How to Make Photodrawings

Our techniques utilizes three steps to produce a high quality photodrawing.

- Take the picture.
- Produce a screened positive.
- Add the engineering information.

Making the photograph for a photodrawing is not simple. To make a high quality reproducible for the drawing base, it is important that the picture be taken from the correct camera angle using the appropriate film, camera and lighting.

In the early stages of the program, we thought that it might be practical for the engineers and designers to take the pictures and then have the photographic department make the photodrawing.

It soon became apparent that this plan did not work. Now the procedure is to send a team consisting of a photographer and an engineer-designer to the field to make the photographic backgrounds.

The designer is experienced in the engineering aspects of the photodrawing technique. He is cognizant of some of the potentialities as well as the limitations of the photographic system.

The photographer is skilled in those phototechniques that give photodrawings properly oriented for engineering purposes. He is also aware that the photograph must have the desired tonal characteristics for the addition of engineering information to the screened positive and for its eventual reproduction.

Correct Photography Is Essential

Most field photos are made with cameras which have a wide field of view and are small in size. This wide field of view is necessary in order to photograph in the narrow spaces between chemical process equipment and to eliminate as many multiple views as possible.

Selection of the angle of view for a photo is dictated by the arrangement of the existing or proposed features such as piping and process vessels or by structural ele-

ments such as beams and walls. In general, a view is made wherever existing elements are to be moved or removed or where new construction is added.

If practical, views are made so that the angle described by the axis of the camera and the principal planes of the subject exceeds 30 degrees. Thereby, very oblique perspective is avoided.

Selection of film type, exposure time, lighting and film processing are aimed at control of gross scene contrast with a maximum of detail. Most indoor locations are photographed by the technique known as the open-flash method. A long time exposure at a small aperture stop is made with one or several photoflash lamps fired during the exposure.

Selection of position and direction of the lamps depends on the existing light on the subject. The object is to get even light on the principal planes of the subject. Rarely is a flash attached to the camera nor is a flash lamp synchronized with a short shutter speed.

The film is processed in the conventional manner with slightly less than normal development time to keep contrast low. Conventional photo prints are made of each exposure. The designer uses these prints to plan the photodrawings that he will need to represent adequately the change or addition. Many times, it is desirable to combine several views on one drawing to get the desired continuity.

Using a photo-enlarger, a screened positive transparency is made by projecting the negative on to a matte surface material. A polyester resin base material is most suitable for photodrawings. The base material is held in a vacuum frame in contact with a halftone screen.

Exposure of the screened positive is determined by the amount of light falling on the film plane as projected from a non-specular highlight of the scene. This exposure is determined with a sensitive photometer.

The exposure usually consists of a basic density exposure plus a flash exposure made with the negative carrier removed from the enlarger. The flash exposure is balanced with the basic exposure to produce a positive having a tonal range within the limits of a 70% dot pattern in the deepest shadow and a highlight density of no less than 20% dot. A positive with these characteristics allows both the photographic background and the added engineering information to reproduce well on diazo.

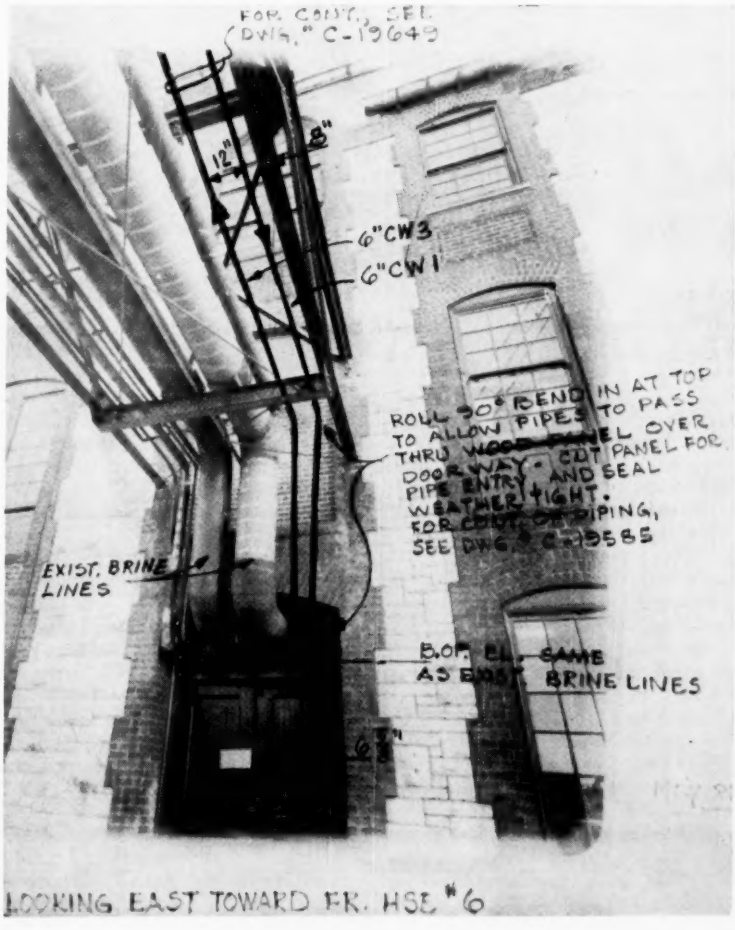
When several views of an area are on one drawing form, multiple images are produced by successively exposing the necessary photonegatives on one piece of film. Multiple images are also made by copying photoprints and making the screened positive from this composite copy negative.

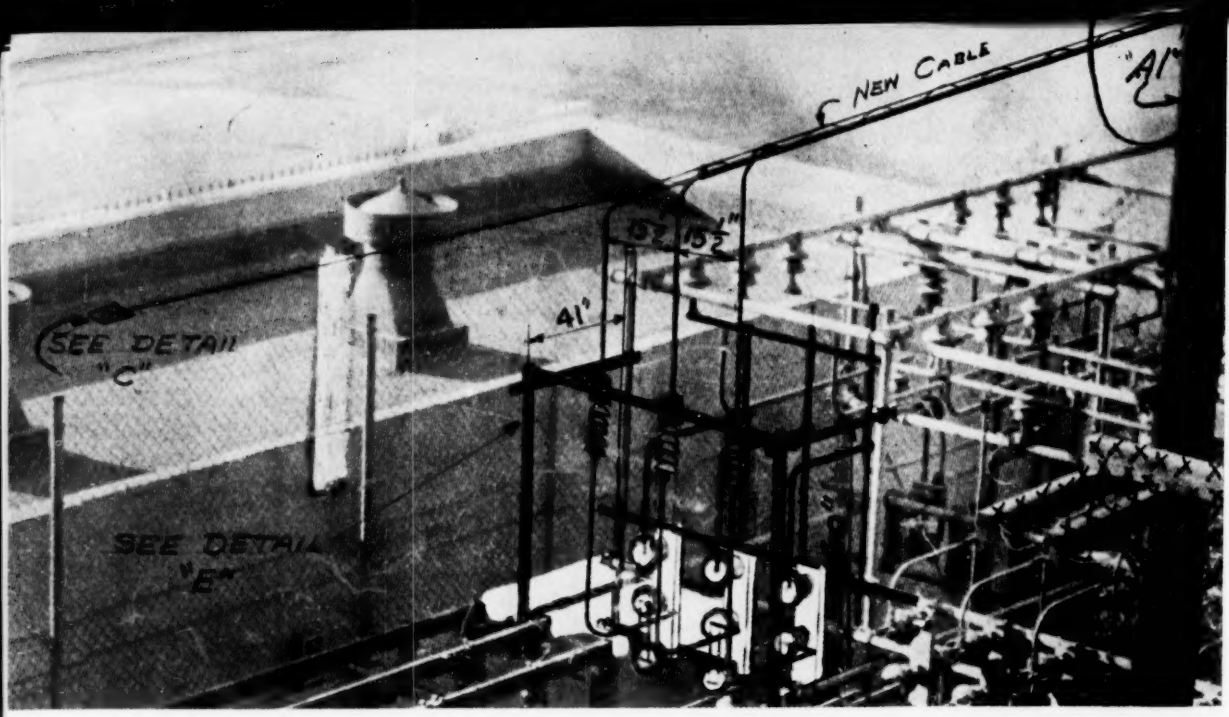
The final screened positive is a left or reversed reading image. Hence, drawing of engineering information is on one side of the film base and the screened photo image on the other. This arrangement enables the photo to print on diazo with maximum fidelity and be less vulnerable to damage when the engineering information is added.

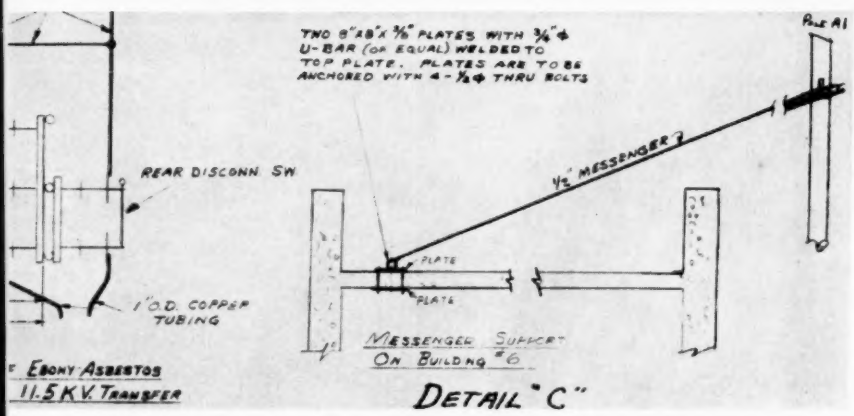
Add Changes to Photodrawing

Every designer and draftsman has a slightly different style of drawing on the photodrawing. As these drawings have found wider application, a general procedure has evolved. Unless the individual is very familiar with the phototechnique and knows the information he will show on the drawing, it is usually desirable to obtain a print of the photodrawing. Then the design information can be planned and laid out on this print. This operation allows the designer to get a better and clearer arrangement of the information while also experimenting with the perspective angle for drawing in the revisions.

Each photodrawing will have a


FOR CONT., SEE DWG." C-19649
12"
8"
6"CW3
6"CW1
ROLL 90° BEND IN AT TOP TO ALLOW PIPES TO PASS THRU WOOD PANEL OVER DOORWAY - CUT PANEL FOR PIPE ENTRY AND SEAL WEATHER TIGHT. FOR CONT. OF PIPING, SEE DWG. C-19585
EXIST. BRINE LINES
B.O.P. EL. SAME AS EXIST. BRINE LINES
LOOKING EAST TOWARD FR. HSE "6




TWO 8"AB"x 3/8" PLATES WITH 3/4"ϕ U-BAR (OR EQUAL) WELDED TO TOP PLATE. PLATES ARE TO BE ANCHORED WITH 4-7/8ϕ THRU BOLTS
REAR DISCONN SW
1/2" MESSENGER
PLATE
PLATE
1" O.D. COPPER TUBING
MESSENGER SUPPORT ON BUILDING #6
EBONY ASBESTOS 11.5 KV. TRANSFER
DETAIL "C"

Photodrawing locates new facilities and shows necessary details.

slightly different vanishing point. It is important that the designer determine this point approximately and draw in the new information with the same perspective. Otherwise, the photodrawing will have a peculiar appearance and in many cases will convey the wrong impression as to design intent to the construction force.

On many projects, there will be 30 to 50 photodrawings which must be tied together for continuity. Of course, each photodrawing is referenced to the succeeding one. Also, it has been found desirable to make a key plan where several drawings are needed.

This key plan is a simple plot plan drawn approximately to scale. On this plan the photodrawing numbers are indicated with arrows showing the approximate direction in which each picture is taken. This allows the field people to orient themselves and also find the appropriate photodrawing for any given area.

There are no unusual mechanical problems in drawing on photodrawings. By using a very soft pencil, heavy black lines and controlling the printing speed on diazo, it is possible to make the additions stand-out in contrast to the existing photographic background.

When making piping drawings, a single line representation is best. In a few cases double line or shaded double line representation is necessary for clarity. However, our experience is that double lining causes many problems with perspective and results in poor appearance of the finished drawing. For these reasons, we avoid the use of double line representation for piping.

Our normal procedure in photodrawings is to show design intent. Only important control dimensions are shown as compared to complete dimensioning for construction. Most of our piping layout is done in this manner for two reasons.

• Our emphasis is on field construction for the prefabrication of piping. The field force makes dimensioned sketches from field measurements for the pipe fabrication shop. This shop also does dimension checking to be sure of the correct fit of the prefabricated piping. Since piping is fabricated from field dimensions, we avoid duplicating these dimensions on drawings made in the engineering office.

• Even though completely dimensioned drawings are available, the field force sometimes makes changes resulting from problems arising during construction. These changes, of course, decrease the desirability of making detailed drawings.

This concept of dimensioning also applies to other fields such as electrical and structural. To repeat, the question of dimensioning should not detract from the cost saving features of photodrawing.

What Does It Cost?

To establish exact cost comparisons between photodrawings and

conventional drawings is difficult because one never does the same job twice. However, by examining past job histories an impartial designer can estimate conservatively the number of conventional drawings necessary to present the same information. From the number of conventional drawings, we can assign an average hourly drawing cost.

Three recent jobs were examined in this manner. We estimate that 20 to 60% more man-hours are necessary to do the drawings by conventional methods than with photodrawings. These savings are real but are attainable only with the correct photographic equipment and application.

At The Procter & Gamble Co., we already had a photographic facility which could be expanded to accommodate this large engineering load. For companies without a photographic department, it is difficult to apply this technique.

In general commercial photographers do not supply this service. Even when they do, there is the problem of service and speed. With our own photographic staff, we can take pictures one day and have screened positive reproducibles ready for drawing on the next day. Speed is important if the technique is to be fully applied. We found that designers and draftsmen tend to revert to conventional methods if they have to wait for the photodrawing reproducibles.

If a company has dark room facilities, an investment of about $3,000 is necessary to buy the special equipment which is necessary to make the screened positives. With the basic equipment, it is possible to produce the photographic drawing base having one image for about the following figures:

Drawing Size, In.	Material Cost, $	Labor, Man-Hour
9 x 12	0.55	1.0
12 x 18	0.85	1.4
18 x 24	1.70	1.8
24 x 36	3.40	2.0
30 x 42	4.50	2.5

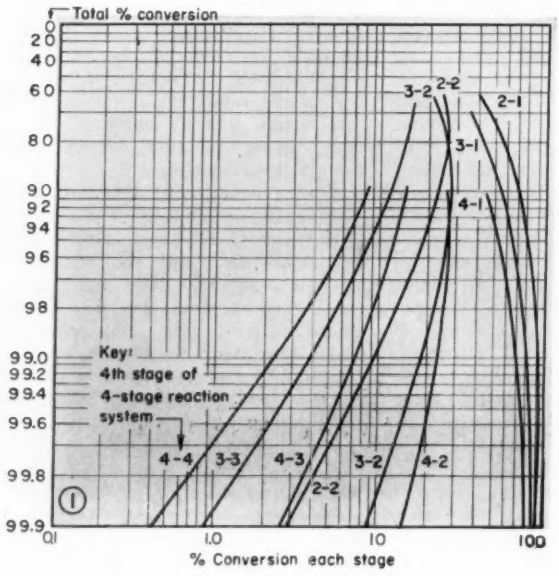
The labor figures are in man-hours so that any company can apply its average hourly rates. These labor figures include the average cost of taking the picture and making the reproducible. It is anticipated that further work in this field will appreciably reduce the cost of photodrawings.

A good example of this cost reduction is the making of a photodrawing with multiple images on one sheet. At first, the 30-in. x 42-in. size required four man-hours when five or six images were placed on one drawing. We can now make this reproducible in about two man-hours. This time is below the previous average for a single image on this size drawing.

We have used photodrawings for changes and additions to existing facilities such as piping, electrical, mechanical, structural, architectural and site clearance. By constantly thinking photographically our engineers and designers are continually finding more applications.

Multiple-view photodrawings save time and drafting when making revisions to mechanical equipment.

All First-Order Reactions



For these reaction systems . . .

- Two stage.
- Three stage.
- Four stage.

In either type of operation:

- Continuous concurrent, or
- Continuous countercurrent.

Charts Give You Percent Conversion in

Now you can eliminate most of the tedious calculations often required to estimate the conversion in each reactor stage.

T. M. JENNEY, Food Machinery and Chemical Corp., Becco Chemical Div., Buffalo, N. Y.*

Designing a system to handle a reaction can be a difficult and time-consuming engineering job.

Often, a batch or continuous operation of one or more stages may be the most economical reaction system. The optimum system must take into account reactor investment and operational costs which are dependent on production level and reaction rates.

We know that chemical reaction rates are influenced by many factors: concentration, temperature, pressure, catlysts, etc. And the tedious task of designing a reaction system is further complicated by the extensive calculations required to establish the most economical excess of reacting components as well as the most economical conversions.

This article is dedicated to eliminating tedium. The seven charts presented here will eliminate most of the tedious calculations required to estimate the conversion in each stage of two-, three- or four-stage reactor systems.

The effect of staging reactions has been discussed in numerous articles and textbooks. This article is actually an extension of our previous article "Charts Simplify Job of Designing Your Reactor System," which appeared on p. 198 of the Dec. 1955 issue of *Chemical Engineering*. However, the charts in this current article are not limited to use in conjunction with the charts of the 1955 article. They may be used independently.

These charts are useful in that they eliminate the necessity for detailed calculations when it's necessary to supply heat exchange or other miscellaneous operations between the reaction stages. The seven graphs cover apparent or pseudo first- and second-order reactions for two-, three- as well as four-stage reactor systems.

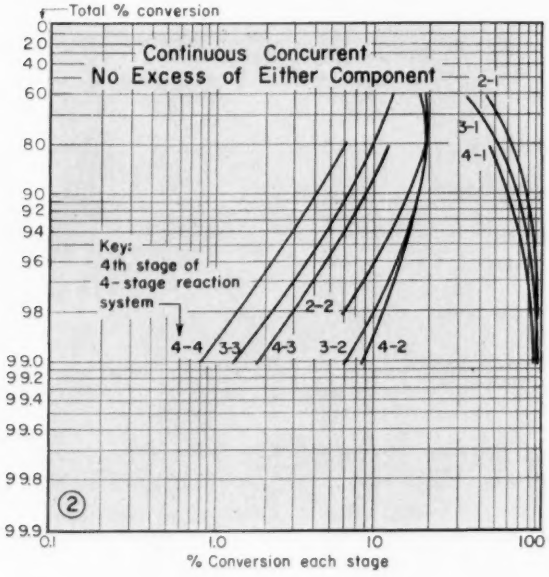
Effect on the reaction rate of variables such as volume, pressure and temperature changes have been neglected. These effects can be inserted by the designer after using the charts. The stages are of equal volume and the contents are assumed to be completely mixed.

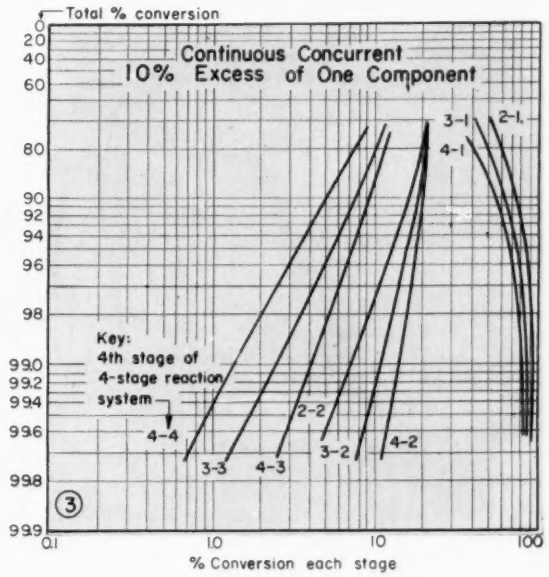
How to Use the Charts

Here are two sample problems which will show how to use the charts in this article.

Problem—In the case of the hydrolysis of chlorobenzene to phenol, using a large excess of caustic, the reaction is pseudo-first order with respect the chloro-

*Meet your author on p. 202.





Each Reactor Stage

benzene concentration due to the large excess of caustic.

Find the conversion in each stage of a four-stage reaction system when the total conversion in the system is 99%.

Solution—From Chart 1, we can read the conversion in each stage as follows:

In the first stage, 68% conversion; in the second stage, 22% conversion; in the third stage, 6.8% conversion; in the fourth stage, 2.2% conversion. Giving a total conversion of 99.0% for the four-stage reactor system.

Note that the conversion is so low in the third and fourth stages that heat removal equipment might not be required between the stages or after them.

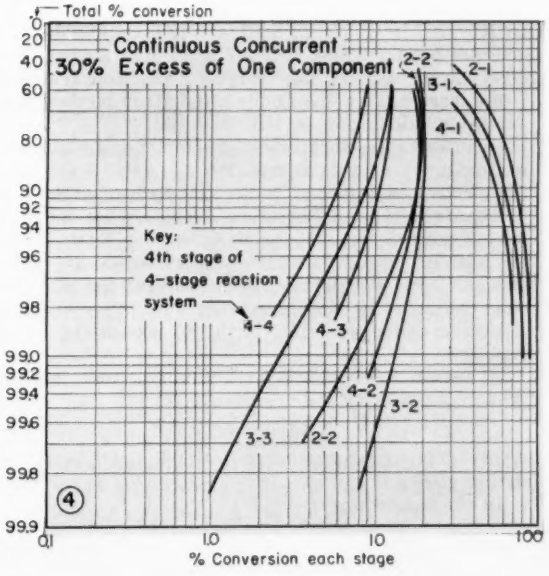
Problem—In the case of the chlorination of many organics such as benzene the reaction is second order. Continuous countercurrent operation is obtained by passing the off-gas from the last reactor back to previous reactor, etc.

Find the conversion in each of four stages at a 99% conversion assuming that there is 10% excess of one component in the reaction system.

Solution—From Chart 6, we can read the conversion in each stage as follows:

In the first stage, 35% conversion; in the second stage, 40% conversion; in the third stage, 20% conversion; and in the fourth stage, 4% conversion. Giving a total conversion of 99%.

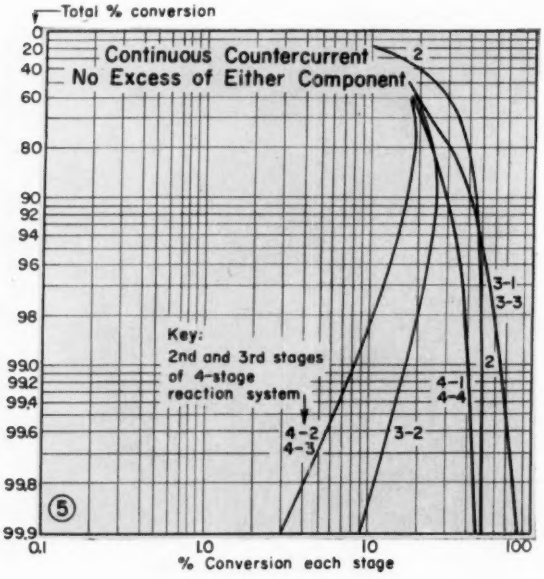
Here, the conversion in the fourth stage is so low that heat exchange might not be required.

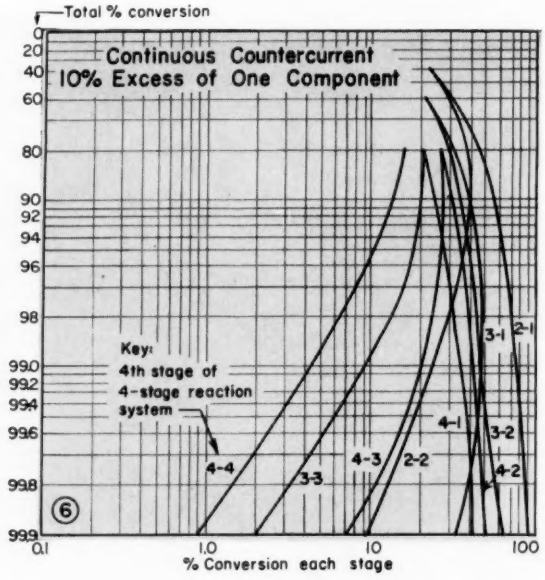


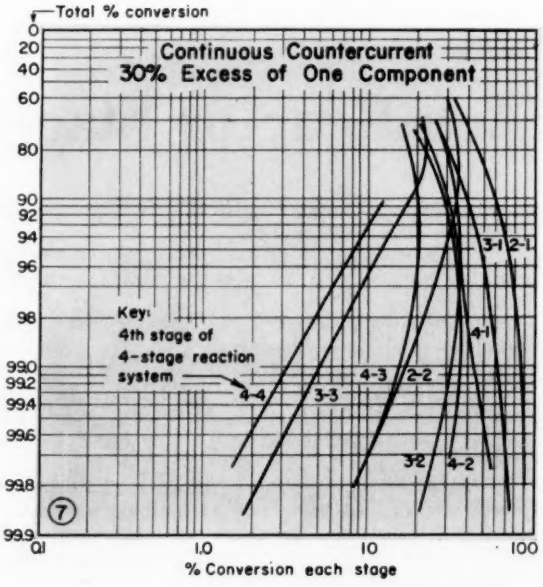
How the Charts Were Built

In 1935 MacMullin and Weber presented a paper entitled "The Theory of Short-Circuiting in Continuous-Flow Mixing Vessels in Series and the Kinetics of Chemical Reactions in Such Systems." This presentation was very complete; however, considerable calculation is required to size a reaction system using the information in the MacMullin and Weber paper.

In 1943, Hurt introduced the concept of reaction







units; and in 1951, Caddell and Hurt extended the original paper. These articles presented a simplified, labor-saving system for designing reaction systems.

But even within the Caddell and Hurt method, considerable calculation is still required.

Our charts are an attempt at simplifying and eliminating much of this calculation.

Calculations required to lay out each of the curves are quite detailed. Therefore, we'll discuss only one set of partial calculations here.

Consider the substitution chlorination of hydrocarbons such as benzene, with the chlorine and benzene contacted by countercurrent flow. This would be a second-order reaction with no excess of either reactant.

A second-order reaction is a bimolecular reaction where the velocity may be stated as:

$$dC/dt = -kC_AC_B$$

where C is concentration; t is time; and k is the reaction constant.

In the case where $C_A = C_B$,

$$dC/dt = -kC_A^2 = -kC_B^2 = -kC^2$$

$$1/C_F = 1/C_o + kt \text{ or } k = (C_o - C_F)/tC_oC_F$$

where C_o is the initial concentration and C_F is the final concentration.

For the construction, C_o was assigned a value of 1.0, for then $(C_o - C_F) \times 100$ would be equal to the percent conversion. We then plotted the stage line for various conversions.

For single-stage continuous operation, the concentration of the reactants in the vessel would be C_F and, therefore, the effective rate would be k times the concentration of one reactant times the concentration of the other:

$$r = kC_FC_F = kC_F^2$$

The amount to be converted would be $(C_o - C_F)$ and, therefore, the time required would be:

$$t = (C_o - C_F)/kC_F^2$$

For two stages, by similar analogy, each stage requires time equal to the conversion of one-half of the total conversion $(C_o - C_F)$.

For the case of three or more stages the approximate conditions were obtained by trial and error. For further details we refer you to our 1955 article.

When you design equipment for . . .

Gas absorption
Extraction
Drying
Crystallization
Distillation

You can use these methods under steady-state conditions.

How to Use Mass Transfer Coefficients

JAMES O. OSBURN, State University of Iowa, Iowa City, Ia.*

In this series we are reviewing the methods of making mass transfer calculations for equipment design and operation. Last month's article, *Chem. Eng.*, Apr. 21, 1958, p. 161 dealt with some background material designed to help you understand the calculations which follow. In that article we explained what molecular diffusion, interfacial resistance and film resistances have to do with mass transfer.

Now we'll show how to make calculations of steady-state mass transfer using mass transfer coefficients. We use these coefficients a great deal for the design of extraction and absorption equipment. The coefficients are simple to use and the results are satisfactory if we don't try to extrapolate too far.

In the calculations to follow, we make certain assumptions which are:

- Equilibrium at the interface.
- Resistances in stagnant fluid films.

These assumptions hold very well in most practical situations and make the calculations much simpler. Let's start with some calculations of transfer across a single film.

Film Coefficient in Gas Absorption

Mass transfer can be looked at as movement from the bulk of one phase across a stagnant film to the interface; equilibrium at the interface with no resistance to flow; and movement across another film, from the interface to the body of the other phase. The films are actually fictitious but the concept is a very useful aid.

The first problem is to calculate the rate of mass transfer across a single film using mass transfer coefficients. Let's take a typical situation pictured in Fig. 1 which might represent conditions at one position in a countercurrent gas absorber. The partial pressure of the absorbed gas is used as a measure of its concentration. Gas A is being removed from the gas phase by mass transfer through a gas film. The partial pressure of A in the gas phase is p_A while at the interface it is p_{Ai}.

Let N_A equal the rate of transfer of substance A across a unit area of film—let's say lb. moles/sq. ft.-sec. We define a mass transfer coefficient k_g by

$$N_A = k_g A\ (p_A - p_{Ai}) \qquad (1)$$

Units Can Be Troublesome

This equation is the basis of many mass transfer calculations. The usual units of k_g are lb. moles/hr.-sq. ft.-atm. The use of mass transfer coefficients is complicated somewhat because different units of driving force are sometimes used. For example, for liquid films we use concentrations instead of partial pressures. We now define the resulting liquid film coefficient k_L by the equation:

$$N_A = k_L A\ (c_i - c) \qquad (2)$$

For mass transfer toward an interface, we use the term $(c - c_i)$.

Concentrations of A are usually expressed as lb.moles/cu.ft., lb./cu.ft or gram moles/l.

For concentrations expressed in mole fraction y, we write the film coefficient k_y and the equation as

$$N_A = k_y A\ (y - y_i) \qquad (3($$

where y is either mole fraction or mole ratio.

Most textbooks and articles use k_g and k_L. However, it is sometimes necessary to recalculate a coefficient which is given in the literature in another set of units.

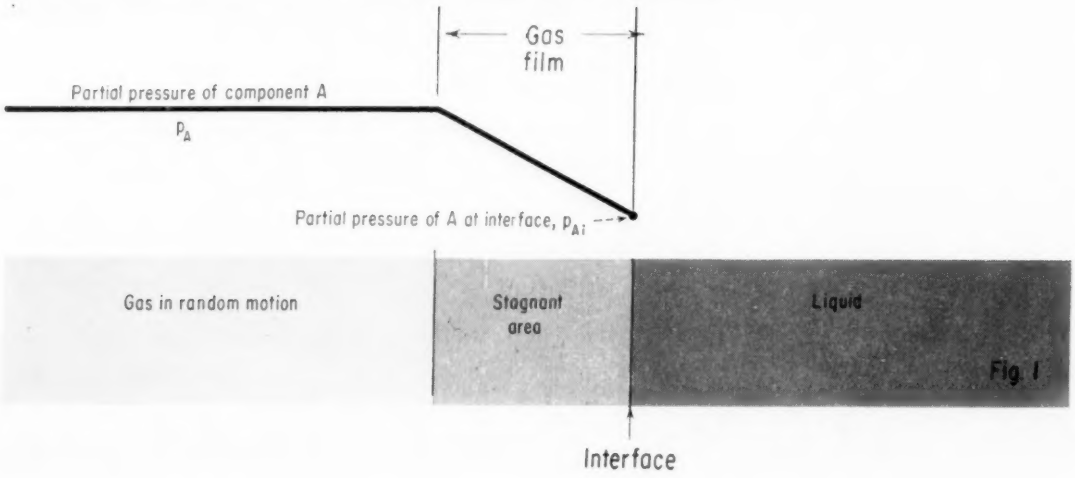
How to Use Volumetric Coefficients

In wetted wall towers, we measure the area for mass transfer. In most other types of equipment this is not the case. However, we can measure the volume of the equipment. Hence, we introduce the term a to represent the interfacial area per unit volume.

$$a = A/V \qquad (4)$$

*To meet your author see *Chem. Eng.*, Mar. 24, 1958, p. 169.

Drop in Partial Pressure Through Gas Film Measures Gas Absorption



We now rewrite Eq. (1) to give

$$N_A = k_g a V (p_A - p_{Ai}) \quad (5)$$

Thus the volumetric coefficient $k_g a$ which we usually find listed in handbooks and magazines depends on both the mass transfer rate and the degree of mixing or dispersion provided by the equipment.

Consider Mass Transfer Across Single Film

Let's assign some values to the quantities in Fig. 1 and use Eq. (5) to calculate the rate of mass transfer. Let $p_A = 0.20$ atm., $p_{Ai} = 0.10$ atm., $k_g a = 0.4$ lb.moles/hr.-cu.ft.-atm. and $V = 1$ cu.ft.

Therefore, the rate of transfer of A to the interface is

$$N_A = (0.4)\ (1)\ (0.20 - 0.10) = 0.04 \text{ lb. moles/hr.}$$

Why Volumetric Coefficient Is Not Constant

If the volumetric coefficient $k_g a$ were essentially constant, the use of film coefficients would be entirely satisfactory. However, it is not constant and depends on a number of factors which are:

1. Nature of the substance being transferred and the inert materials through which it moves. In particular, it depends on some power of the diffusion coefficient.
2. Temperature. Some film coefficients increase as temperature increases, others decrease.
3. Flow rate of phase in which the film exists. For gases, the film coefficient varies approximately as the 0.8 power of the flow rate. When the amount of gas changes due to mass transfer as the gas passes through an absorber, the film coefficient changes. This disadvantage led to the development of the transfer-unit method.
4. Flow rate of the other phase. This can affect the active area a per unit volume.
5. Nature of the equipment. This effect is due mainly to variations in a. It is often approximated for tower packings by assuming that $k_g a$ is proportional to the measured surface area of the packing in a unit volume.
6. Pressure.
7. Concentration.

Because of the sensitivity of $k_g a$ to so many factors, its use is limited to design of equipment from data taken under identical conditions or to design of absorbers for dilute gases.

Let's Examine Over-All Coefficients

We have shown how to calculate the rate of transfer across one film. But in general, there will be resistances across both films. Exceptions are

- Evaporation or condensation of a pure substance.
- Mass transfer where one film has a much greater resistance than the other.

In the first case there is only one component in the liquid phase. Consequently there can't be any resistance in this phase.

When one film resistance is very great, this film is said to control. In absorption, the gas film usually controls when it is only slightly soluble.

Now let's extend the first illustration by assuming that material which reaches the interface then passes through another film to reach the bulk of the other phase. With steady-state operation the concentrations of the two phases remain constant, and there is no buildup of A in the films or the interface. The complete picture is shown in Fig. 2.

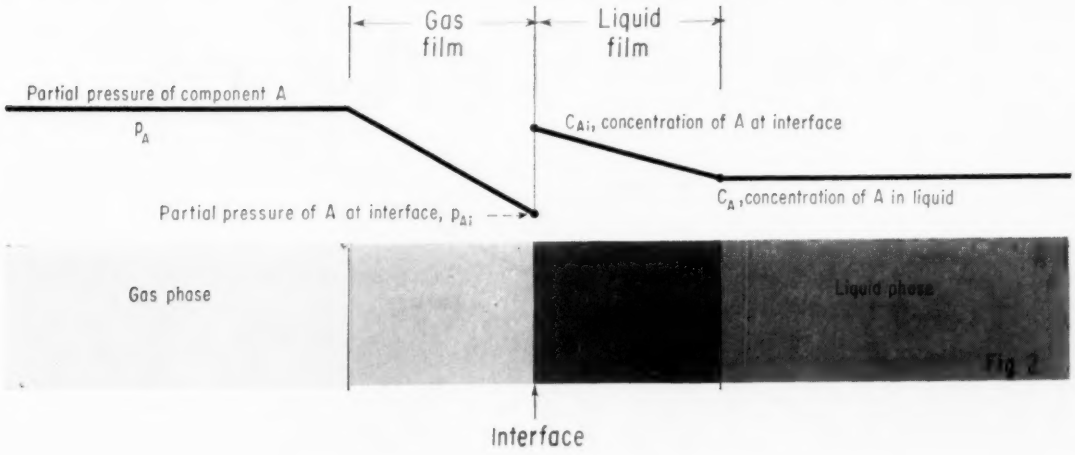
Equilibrium at the Interface

At the interface, the concentration c_{Ai} is that which is in equilibrium with p_{Ai}. The equilibrium relationship can be shown on a diagram such as Fig. 3 or as a Henry's law constant. For the hypothetical system in Fig. 3,

$$H = p_i/c_i$$

The symbol c^* denotes the phase concentration which would be in equilibrium with the bulk of Phase 1, and p^* is the Phase 1 concentration in

Mass Transfer From Gas to Liquid Meets Resistance in Both Phases



equilibrium with Phase 2. Assigning the value of 0.04 to c, we show in Fig. 3 the values of each of the concentrations to be used in the following example.

In our first illustration, the rate of mass transfer was 0.04 lb. moles/hr. in a volume of one cu. ft. This amount must be transferred through the Phase 2 film. The rate is given by the following equation which we derive from Eq. (2):

$$\begin{aligned} N_A &= k_L a V (c_{Ai} - c_A) \\ 0.04 &= k_L a\ (1)\ (0.20 - 0.04) \\ k_L a &= 0.25 \end{aligned} \qquad (2a)$$

What are the Over-All Coefficients?

The previous example illustrates the calculations which are possible if the interfacial concentration is known. However, interfacial concentration can never be measured directly. Therefore, coefficients based on observable concentrations are more useful.

These are the over-all coefficients which may be based on the concentrations in either phase.
For the gas phase:

$$N_A = K_G a V (p_A - p_A^*) \qquad (6)$$

For the liquid phase:

$$N_A = K_L a V (c_A^* - c_A) \qquad (7)$$

Using the known values from the example and applying Eq. (6) gives:

$$\begin{aligned} 0.04 &= K_G a\ (1)\ (0.20 - 0.02) \\ K_G a &= 0.222 \end{aligned}$$

We can calculate $K_L a$ using Eq. (7).

$$\begin{aligned} 0.04 &= K_L a\ (1)\ (0.40 - 0.04) \\ K_L a &= 0.111 \end{aligned}$$

If we repeat the calculations using symbols instead of assuming values, we derive the equations:

$$\frac{1}{K_G a} = \frac{1}{k_g a} + \frac{H}{k_L a} \qquad (8)$$

$$\frac{1}{K_L a} = \frac{1}{k_L a} + \frac{1}{H k_g a} \qquad (9)$$

We can use these equations to verify the values of $K_G a$ and $K_L a$ that we previously calculated.

Over-all coefficients are generally the ones used for design calculations. It is sometimes possible to estimate the individual film coefficients separately. In this case they are used to calculate the over-all coefficient.

Use Film Coefficients for Extraction

In the previous illustration, we assumed that we had a gaseous phase and a liquid phase. This example corresponds to the unit operation of absorption. It can apply equally well to other operations where there is resistance to mass transfer in a fluid phase. For example: in liquid extraction, there are two liquid films. Equations similar to Eq. (2a) may be written for either phase, or an equation similar to Eq. (6) using an over-all coefficient may be written.

Apply Method to Drying Operations

Mass transfer coefficients are most commonly used in absorption and extraction. They are sometimes applied to other mass transfer operations such as drying, crystallization and distillation.

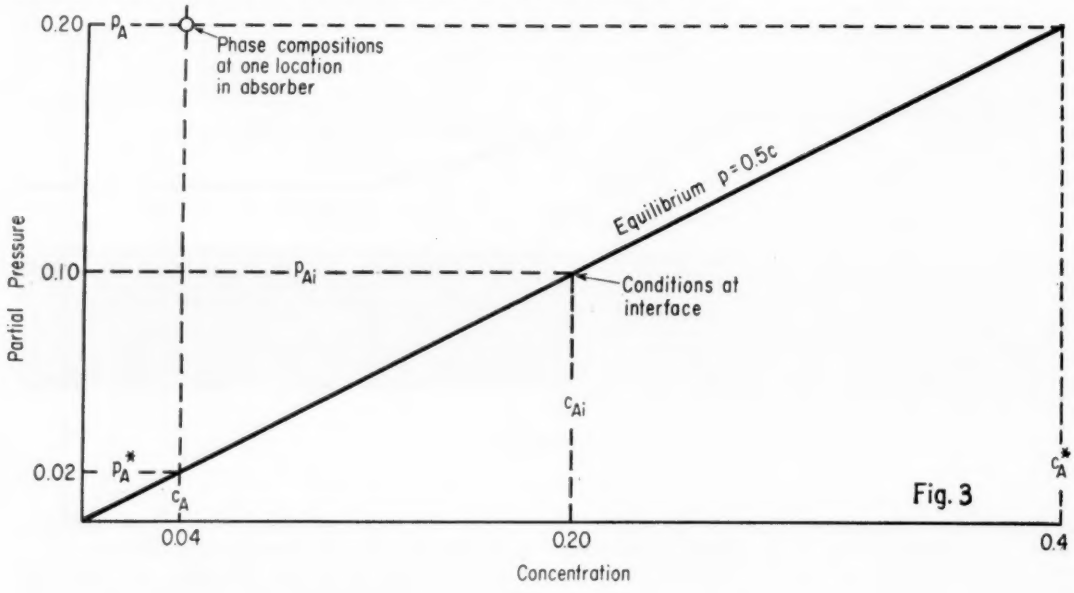
The rate at which a solid dries depends on the movement of liquid to the surface as well as the rate of mass transfer from the surface. During the constant rate period of drying, however, the surface is saturated. Hence, the drying rate is fixed by mass transfer. Then for constant air temperature, velocity and humidity, we can use a mass transfer coefficient to calculate the drying rate of a solid.

The effect of air humidity on the drying rate can be calculated for the constant rate drying period by using the following equation:

$$\frac{dW}{d\theta} = k_g a (p_A^* - p_A) \cong k a (H_s - H) \qquad 10)$$

The term p_A^* is the saturation partial pressure

Here Are Equilibrium Phase Concentrations For Typical Problem



of water vapor at the wet-bulb temperature of the air. H is the humidity of the air, H_s is the humidity of the air at saturation.

The equation is only approximate because it assumes a linear variation of humidity with vapor pressure. This assumption is satisfactory over a moderate range.

Problem—The measured drying rate of a solid material is 0.24 lb/sq.ft.-hr. during the constant-rate period. The air has a wet-bulb temperature of 90 F. and a dry-bulb temperature of 110 F.

What is the effect on the drying rate if we increase the dry-bulb temperature to 130 F while keeping the wet-bulb temperature at 90 F?

Solution—From a psychrometric chart, we find the following humidities:

Absolute Humidity	Original	New
H, lb. water/lb. dry air	0.0262	0.0213
H_s, lb. water/lb. dry air	0.0310	0.0310

Under the original conditions,

$$k\,(H_s - H) = dW/d\theta$$
$$k = 0.24/(0.0310 - 0.0262) = 50 \text{ lb./sq. ft.-hr.}$$

Assuming that k is constant, we find the rate for the new conditions.

$$dw/d\theta = 50\,(0.0310 - 0.0213) = 0.485 \text{ lb./sq. ft.-hr.}$$

Coefficient for Crystallization

Most of the design of crystallizers deals with crystal size and yield, with capacity determined empirically. However, experiments on crystallization rates have led to equations which include a mass transfer coefficient. A typical equation is

$$dm/d\theta = KA\,(C_B - C_S) \qquad (11)$$

In this equation, m is the mass of the crystal formed, C_B the concentration of the solution at the growing face of the crystal and C_S the concentration of the saturated solution.

This equation isn't very useful for design. First, because C_B and A are difficult to determine and also because changes in temperature vary C_s.

How Coefficients Apply to Distillation

Although distillation takes place by mass transfer, rate coefficients haven't been generally used for design calculations. Because equipment usually operates stagewise, the design usually involves calculating the number of theoretical stages. Given enough time for mass transfer to take place in each stage, an actual stage would behave as an ideal one. Actually, the contact between phases is too rapid and consequently the stage efficiency is less than 100%.

The mass transfer coefficient enters distillation equipment design through the stage efficiency. Although the efficiency is generally found by experiment and correlation, it depends on a mass transfer coefficient according to this equation:

$$E_M^* = 1 - e^{-(K_g a Z/G)} \qquad (12)$$

E_M^* = Murphree point efficiency
G = Gas rate
Z = Liquid depth

Coming

Thus far our discussion has been about mass transfer between phases of constant composition. When we look at equipment in operation, we see that the phase compositions change throughout. In designing equipment, we have to take these concentration changes into account. In our next article, we will show how to use mass transfer coefficients under varying conditions.

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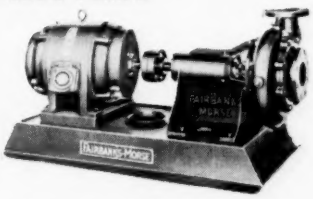

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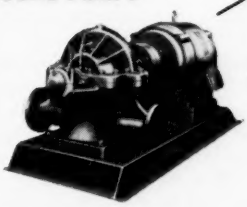

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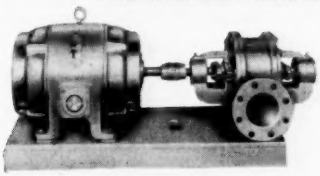

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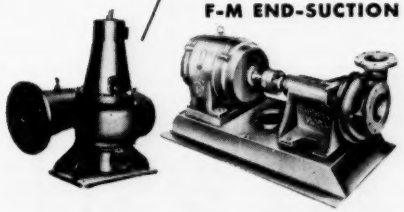

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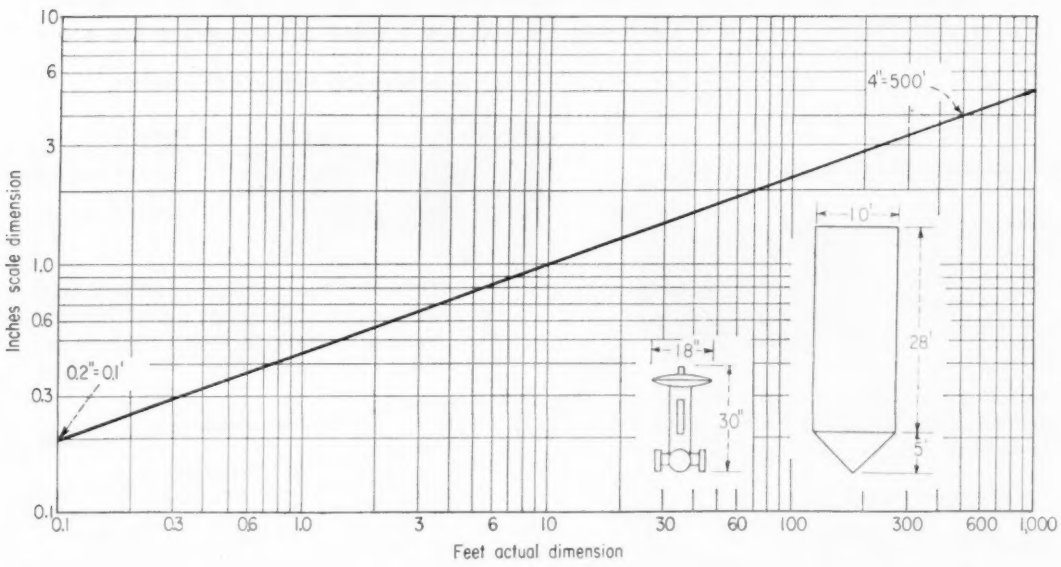

Handy Way to Scale Drawings for Flow Sheets

In portraying widely varying equipment sizes on flow sheets here's a scaling method that gives a concept of relative size.

★Winner of March Contest by Robert H. Berg
Process Control Services Co., Elmhurst, Ill.

In making schematic drawings of chemical processing plants—for process flow sheets, for example—we generally want to increase the speed of recognition of the various pieces of equipment by using individual line sketches showing the principal view.

This brings up the question of how to scale the sketches so that their relative sizes are consistent, esthetically suitable and most understandable.

The method of scaling proposed here makes use of a logarithmic relationship between the scale factors of the various pieces of equipment. This system gives relative sizes which are in approximate agreement with the relative proportions pictured by the mind's eye. That is, one's mental picture of an object is based on its proportions when viewed from a distance which affords a satisfactory image of the entire object.

Thus, large objects such as kilns, storage tanks and furnaces are usually pictured in the mind as seen from a distance of tens or hundreds of feet. Smaller objects such as control valves, pumps and mixers are pictured as from 5 or 10 ft. distance.

In setting up a scaling chart on a piece of log-log paper our first task is to determine the limits of the largest and smallest objects to be shown. Suppose, for example, these are a 500-ft. kiln, and a 0.1-ft. pushbutton. From the desired size of the finished drawing we determine that the kiln should scale down to 4 in. and the pushbutton to 0.2 in. This is the way the chart above is set up. The scale-factor line passes through the two points represented by 500 ft. actual = 4 in. drawing size, and 0.1 ft. actual = 0.2 in. drawing size. However, we might have selected any other pair of points depending on the size range and the size of drawing desired.

With a little experience it is easy to estimate the amount of material for a given drawing, the required size of drawing paper and the size limits of equipment to be shown.

In scaling the various pieces of equipment we take the principal dimension in feet and convert it to inches for the drawing by means of the chart. All other dimensions of the same object are kept in proportion to the principal dimension by using the same scale factor as for the principal dimension. For example the 10-ft.-diam. tank, 33 ft. high, shown superimposed on the chart, scales to 1.5 in. high.

At SOHIO Petrochemical Plant:

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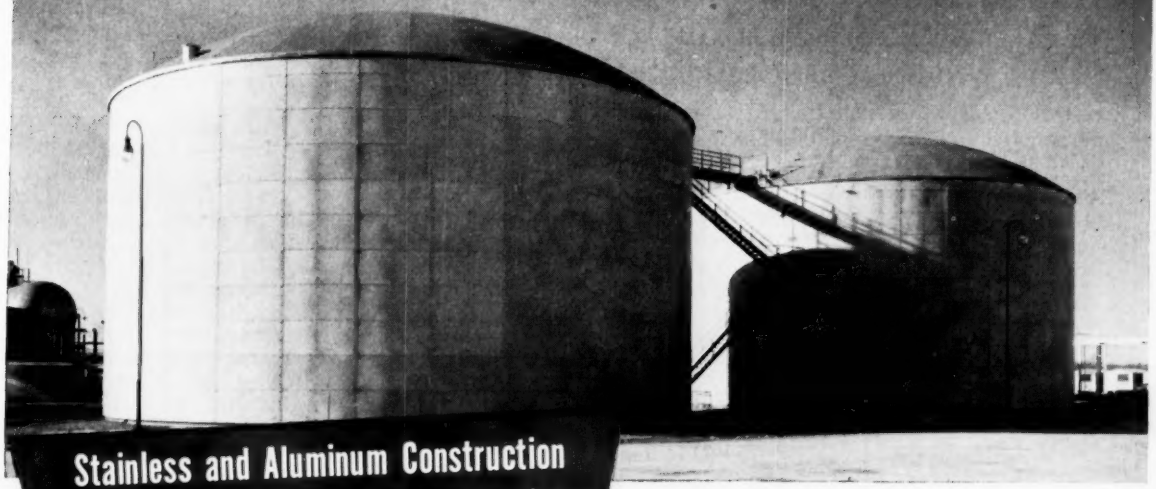

Stainless and Aluminum Construction extends useful life of storage structures for ammonia and derivatives

At Sohio Chemical's $17 million ammonia plant, near Lima, Ohio, extensive use was made of stainless steel and aluminum for tanks used to store the highly corrosive products of this new petrochemical operation.

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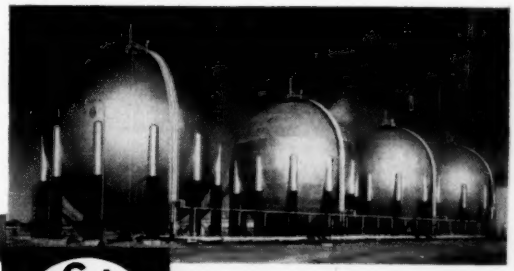

OTHER CB&I STRUCTURES at Lima plant include a 30-foot diam. 304ELC solid-stainless tank for nitric acid storage, aluminum drums for ammonium nitrate solution and the four 20,000 barrel Hortonspheres® above.

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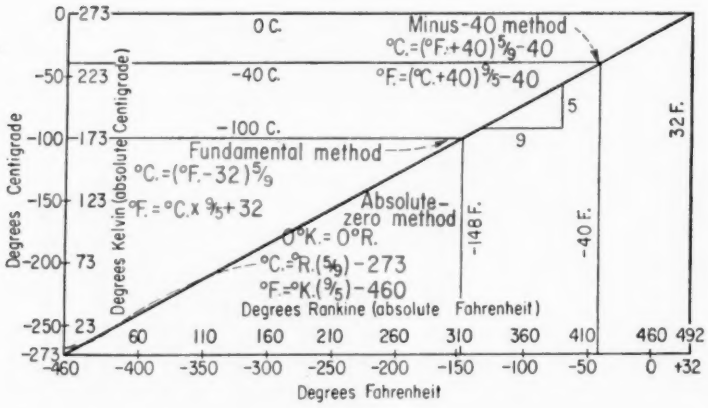
Hence, the scale factor is 1.5/33 = 0.045 in./ft. Then the diameter becomes 0.045 × 10 = 0.45 in., rounded off to 0.5 in. Similarly, the 2½-ft.-high control valve scales ⅝ in. high, while its 1½-ft. diameter becomes 1.5 × 0.625/2.5 = 0.375 or ⅜ in.



Still Quicker Temperature Conversions

Comment From Readers

In our November 1957 issue, on p. 292, we published a temperature conversion method by George F. Hausenbauer which involved changing the temperature to be converted to absolute, multiplying by 9/5 if Kelvin or by 5/9 if Rankine, and then changing back to the Centigrade or Fahrenheit system.

After appearance of this article 16 readers wrote us to point out that there are simpler methods, 14 of them preferring the "Minus-40" method (see chart) and two preferring the Fundamental method, also shown on the chart. In past years we have published about a dozen methods of temperature conversion, all except the Absolute-Zero method being based on either the Fundamental or the Minus-40 method. (See Walenda, p. 255, Jan. '57.)

As the chart makes clear, the Absolute-Zero and Minus-40 methods are similar. Hausenbauer bases his method on the equality of −273 C. (0 Kelvin), and of −459.6 F. (0 Rankine). The Minus-40 method is based on the equality of −40 C. and −40 F. It would appear that the Minus-40 method is simpler when expressing the temperatures in the Centrigrade-Fahrenheit system, while the Absolute-Zero method is simpler when dealing with temperatures already expressed in the absolute system.

Our thanks to the following readers for their interest: W. R. Botham, Heighington, England; S. K. Brimacombe, Reichhold Chemicals (Canada) Ltd.; S. Cowan, Dominion Tar & Chemical Co. Ltd.; Elvin Greene, Union Carbide Nuclear Co.; Michael T. Hall, Crewe, Cheshire, England; John T. Herb, Atomic Power Development Associates; E. C. Mann, Jr., Harshaw Chemical Co.; W. A. Mason, Stockton-on-Tees, England; Richard Moran, E. I. du Pont de Nemours & Co.; D. E. Middleton, Kimberly-Clark Corp.; D. A. Nelson, E. I. du Pont de Nemours & Co.; A. H. Raine, Brotherton & Co. Ltd. (England); Jose Sanmaniego, Shell Development Corp.; Morton Sherman, Zonolite Co.; Bill L. Walker, Philips Petroleum Co.; and W. J. Younker, University of Cincinnati.

COMING JUNE 16: Dust- and Water-Tight Unloading Method

By Oliver D. Dressel, Winner of the April Contest

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H. G. Knapp
The Nichols Chemical Co., Ltd.
Sulphide, Ont., Canada

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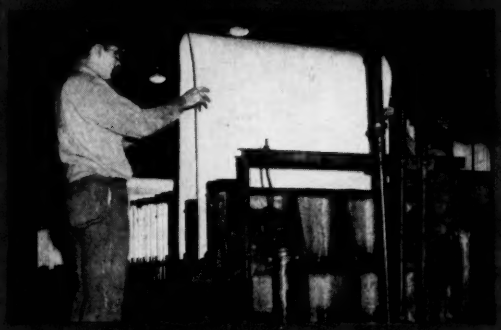
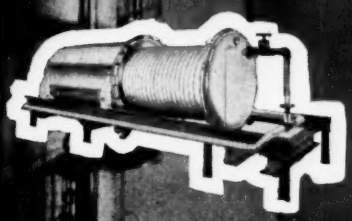
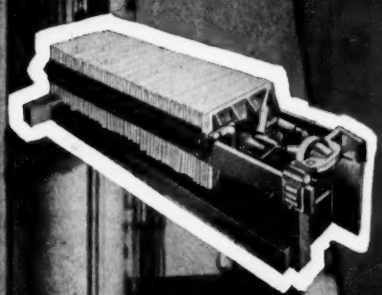
A 4-in. pump-priming line runs about ¼ mi. from the plant out to a pump in the field. To dig a new trench would have been costly since the line runs through rocky soil and under a surfaced road. Many leaks made a repair imperative.

We solved the problem very simply by pushing a single length of 2-in. polyethylene pipe through the old line. The polyethylene was stiff enough to

WINDSOR FELTS







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They're fabricated from selected synthetic fibers to meet your individual specifications... and feature a *unique,* engineered construction with precision controlled pore size which provides the following significant advantages:

- Rapid filter cake build-up
- Minimum recycle time
- High flow rate
- Dimensional stability
- Ravel free, clean cut edges
- Positive gasketing – minimum leakage
- Easy cake release
- Greater product recovery
- Lower cost

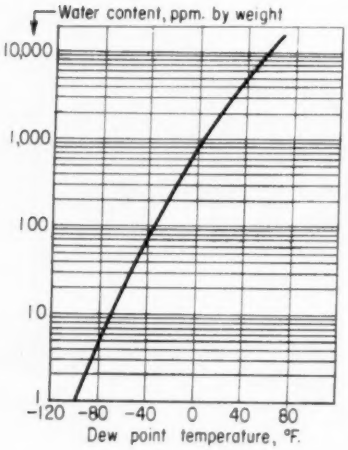
Windsor Felts are *now* in use on all types of filtration equipment... inquire how they can improve *your* operations, write for Data Sheet #18, on company letterhead, please.

Remember: American Felt Company has the most extensive and best equipped staff of product engineers in the Felt industry with *engineered* materials for seals, wicks, decoration, vibration mounts and polishing... for information, write to...

General Offices and Engineering And Research Laboratories 317 Glenville Road, Glenville, Conn.

American Felt Company
TRADE MARK

push through easily. In anticipation of the possibility that we might hit an obstruction we measured the pipe as we pushed it through. Thus, when we came to the only obstruction, a point where the old line had collapsed, we knew exactly where to dig to cut out the bad spot. The new pipe handled plenty of water for the priming job.



Dew Point Gives Moisture Content of Gases

William H. Fischer
General Engineering Laboratory
General Electric Co.
Schenectady, N. Y.

Dew point of gases is relatively easy to measure and is therefore the most frequently used method for determining moisture content. Dew point constitutes the temperature at which the contained moisture starts to condense out. Hence, at the dew point the gas is saturated with respect to water. If the condensed moisture freezes, the term frost point is sometimes used.

Except for gases which react with water, the amount of moisture contained per unit volume of gas at the dew point is independent of the kind of gas.

Sometimes it is more convenient to express the moisture content of a gas in several other ways. The accompanying graph will help in doing this. Here, water content is expressed as parts per million by weight of dry air at 70 F. and 1 atm. total pressure. To use the graph the dew point should be determined near atmospheric pressure.

Knowing the dew point moisture content of air, here are some of the possible conversions:

1. To express the water content as ppm. by volume, multiply ppm. by weight by 29/18=1.611.

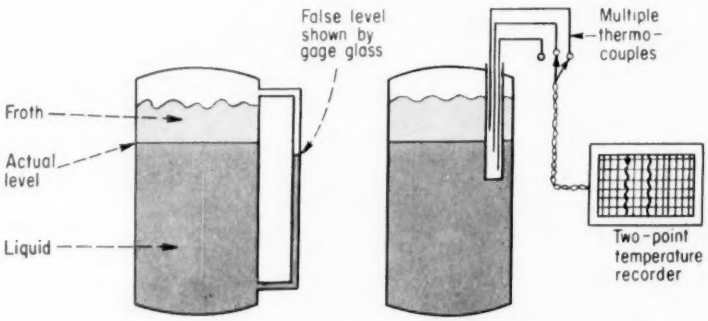
2. To express water content of a gas as percentage absolute humidity, determine its dew point and from the chart find its moisture content at the dew point. This moisture content, divided by its saturation moisture at 70 F., gives the percentage absolute humidity. Since the saturation moisture of 70 F. air is 15,365 ppm., then percentage humidity for air whose dew point is —50 F. (41 ppm.), for example, is:

$(41 \times 100)/15{,}365 = 0.27\%$

3. To express the water content as absolute humidity in terms of pounds of moisture per pound of dry air, divide ppm. by weight by 10^6.

4. To express the moisture content as vapor pressure of water in millimeters of mercury, multiply ppm. by weight by 1.222×10^{-3}.

5. We can also use the chart in determining the moisture content of gases other than air. To do so, measure dew point of the gas. On the chart find the moisture content in ppm. by weight which air would have at the same dew point. Multiply this result by 1.2004×10^{-3} and divide by the weight of the gas in question expressed as grams per liter at 1 atm.



Level Measurement in Frothing Liquids

Jerome A. Seiner*
Design Division, Chemical Corps Phosphate Development Works, Sheffield, Ala.

We often want to maintain a known variable liquid level inside a vessel which contains a violently agitated, bubbling material. Use of a sight glass to show the level, as in the lefthand sketch above, will give a false indication due to the difference in density of the liquid in the glass and the bubbling material inside the tank.

Our solution to this problem was to install a multiple thermocouple through an upper nozzle of the tank as shown in the righthand sketch. Since the vapor space temperature was 100 F. below the liquid, installing one thermocouple just above the desired level and another just below made it possible to read the level accurately and maintain it just where desired.

The two temperatures, one just above and the other just below the desired level, were recorded continuously on a strip chart. Maintaining a large temperature spread between them made for accuracy. To allow for changing the level additional thermocouples can be added with a simple switching arrangement to enable a selected pair of thermocouples to bracket the desired level.

* Present address, Pittsburgh Plate Glass Co., Paint Div., Springdale, Pa.

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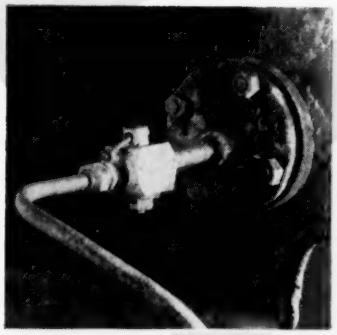
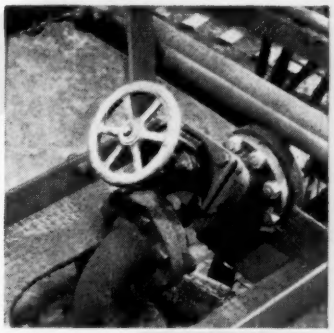
STEEL CORPORATION · PITTSBURGH



One of the first **Durco Type F** valves ever built. This valve has been in continuous service since December 31, 1949, handling 5% sulfuric acid saturated with ammonium sulfate.

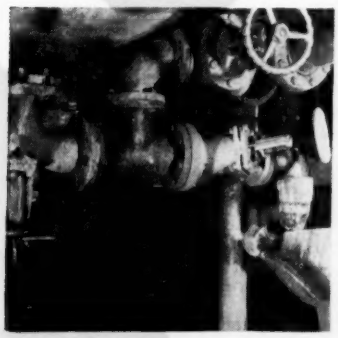


Durco Type J202 Durimet 20 Y valve in service on inlet of 20,000 gals. 66° Baume H_2SO_4 storage tank. This valve replaced a 316 stainless steel gate valve.

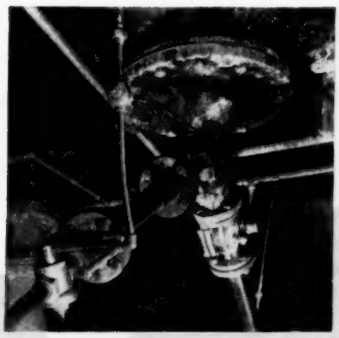
Durcopumps on tank car loading of **residual tar at 200° F.** These pumps **handle approximately** 150,000 gals. a day. **Durcopumps** exclusively are also **used by J & L for tar** distillation units **with temperatures** up to 600° F.

DURCO DEPENDABILITY is the reason for these and many other DURCOPUMP and DURCO VALVE installations at the Jones & Laughlin Steel Corporation's By-Product Plant in Pittsburgh.

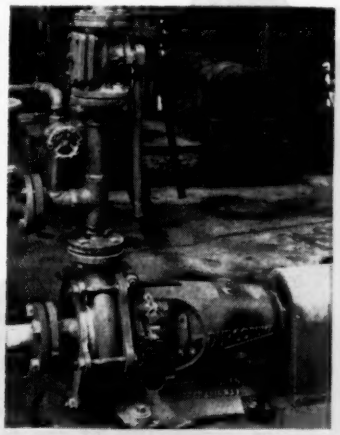
DURCO handles the *tough* corrosives and the *tough* services throughout the chemical process industries. The fact that DURCO equipment can be depended upon for maximum service life with minimum maintenance is the basic reason more people every day are turning to DURCO chemical process equipment. For complete details, call or write: The Duriron Company, Inc., Dayton, Ohio, or contact your nearest Durco Sales Office.



Durco Type J202 Durimet 20 Y **valves handling 60°** Be. sulfuric acid **mixed with coke oven** light oils, and **neutralized by sodium** hydroxide. **These Durco valves** replaced 316 **stainless steel gate** valves that **leaked after six months'** service. The **Type J valves have now** been in **service for more than 1½** years with **no sign of corrosion or** line leakage. **The atmosphere in this area is also severely corrosive.**



Durco Type F valves on lines from constant feed storage tank to centrifugal dryers. The tank contains 5% sulfuric acid saturated with 15-20% ammonium sulfate crystals in suspension.



Series R Durcopump with more than five years' service, and Durco Type F valve with more than three years' service handling Ammonium Sulfate solution at 105° C. "Absolute minimum of maintenance."

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

The mark of dependability in tough chemical service . . . everywhere

THE DURIRON COMPANY, Inc., DAYTON, OHIO

Branch Offices: Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Detroit, Houston, Knoxville, Los Angeles, New York, Pensacola, Fla., Philadelphia and Pittsburgh.

Low carbon content cuts intergranular corrosion . . . but you sacrifice tensile strength.

	Percent Composition					Tensile Strength, Psi.*	0.2% Yield Strength, Psi.*
	C	Mn	Cr	Ni	Mo		
Sheet							
304 L	0.03 max.	2.00 max.	18–20	8–12	.....	82,000	35,000
304	0.08 max.	2.00 max.	18–20	8–12	.....	92,000	40,000
316 L	0.03 max.	2.00 max.	16–18	10–14	2–3	80,000	38,000
316	0.10 max.	2.00 max.	16–18	10–14	2–3	85,000	48,000
317 L	0.03 max.	2.00 max.	18–20	11–15	3–4	.....	.....
Casting							
CF-4	0.03 max.	1.50 max.	18–20	9–12	.....	79,000	34,000
CF-4M	0.03 max.	1.50 max.	18–20	10–13	2–3	79,000	37,000

* Room temperature.

New Alloy Steels Beat Process Bugaboos

There's plenty new in stainless steels. Out of missile and aircraft work: low-carbon and stabilized steels resistant to intergranular corrosion.

D. B. Roach and A. M. Hall, Battelle Memorial Institute, Columbus, Ohio

During and since World War II, interest in stainless steels has mounted dramatically.

Many new members have been added to the family. Several bid fair to become prodigies.

The aircraft industry has added impetus to development of new stainless steels. However, many new compositions, directed originally at aircraft, are especially well suited to numerous chemical operations.

The extra-low-carbon types (0.03% max. carbon) were originally designed to mitigate effects of the columbium shortage. It turns out, however, that these steels have found a place of their own in severely corrosive service, irrespective of the columbium situation.

Such steels as the high-manganese, low-nickel grades, represented by Types 201 and 202, were developed to circumvent the nickel shortage, which no longer exists. Other high-manganese compositions are designed for high-temperature applications.

In addition, several families of age-hardenable stainless steels have made their appearance. These steels combine very high strength with stainless qualities and have a wide variety of applications. They will be discussed in a following article.

It is not our intention to give you a comprehensive discussion of all the recent stainless steels. This would become a lengthy treatise, and many of the steels would be of little interest to you as a chemical engineer. Instead, we've selected illustrative members of several important classes of stainless.

NEXT ISSUE

Precipitation-Hardening Steels

The new PH steels offer high strength and corrosion resistance, produced by a simple heat treatment. In our next issue we will discuss the PH steels of interest to chemical engineers.

▶ **New Low-Carbon Steels** — Four very-low-carbon grades of wrought stainless steel are commercially available today (see table above). They are: an 18Cr-8Ni steel (304L); an 18-8 type containing about 2.5% molybdenum (316L); an 18-8 type containing around 3.5% molybdenum (317L); and a high-manganese, low-nickel grade (204L).

In addition, the high-alloy foundry industry now produces two similar grades of extra-low-carbon casting alloys. These grades carry the Alloy Casting Institute designations, CF-4 and CF-4M. Compositions are given in the table.

The chemical composition for casting grades of stainless-type alloys are not the same as those of wrought alloys. This holds even though types that are nominally counterparts of one another are being considered. Dif-

US PERMOBOND

...“the best tank lining we’ve ever had”

SAYS THIS LARGE ACID-CARRYING FLEET OWNER

One of the largest fleets of acid-carrying trucks in the East is P. B. Mutrie Motor Trans., Inc., owner of about 50 acid tankers. The truck above is one of their newest, and is the largest *rubber-lined* tank truck in New England, and one of the largest in the country. Like the other dozens of Mutrie’s tanks, this one is lined with PERMOBOND,® the rubber lining that is resistant to corrosion, and that prevents iron rust from contaminating the chemical in the tank. This truck also carries a U. S. Rubber Acid Discharge Hose, engineered to fit particular corrosion conditions.

Any container of corrosive acids, no matter how complex its shape, can be lined with PERMOBOND—whether it is original equipment or existing equipment—whether it’s over-the-road tank trucks or railroad tank cars.

So, for any rubber lining requirement, contact tank lining experts at U. S. Rubber, Mechanical Goods Division, Rockefeller Center, New York 20, N. Y.

In Canada, Dominion Rubber Co. Ltd.

Mechanical Goods Division

United States Rubber

High-Manganese Steels Stand Up to Corrosives

	Inches Penetration/Yr.				
	Type 201	Type 301	Type 202	202 H. W.*	Type 304
Boiling 65% nitric acid, five 48-hr. exposures	0.0017	0.0015	0.0015		
Boiling 1% copper sulfate, 8% sulfuric acid, 72-hr. test	0.00003	0.00002			
Air-saturated 5% lactic acid, 86 F., 96-hr. test	0.00001	0.00001			
Air-saturated 10% phosphoric acid, 86 F., 96-hr. test	0.00001	0.00001			
Air-saturated 60% acetic acid, 158 F., 96-hr. test	0.00001	0.00001			
Boiling 50% phosphoric acid, five 4-hr. exposures			0.0003	0.0001	0.0001
Boiling 15% glacial acetic acid, five 4-hr. exposures			0.0000	0.0001	0.0000
Boiling 15% lactic acid, five 4-hr. exposures			0.0000	0.0000	0.0000
Boiling 25% (by wt.) citric acid, five 4-hr. exposures			0.0000	0.0000	0.0000
Boiling 30% (by wt.) tartaric acid, five 4-hr. exposures			0.0000	0.0000	0.0000

* Heliarc Weld.

ference is dictated by the special metallurgical problems of a stainless foundry and of alloys used in the cast condition. The customer is advised, therefore, to use wrought alloy designations when he wants wrought material, and ACI designations when he wants castings.

▶**Cuts Intergranular Attack**—The specific purpose in developing the extra-low-carbon grades was to provide an austenitic stainless steel of superior resistance to intergranular corrosion.

In the ordinary higher carbon grades of austenitic stainless steel, chromium carbides will precipitate in the grain boundaries of the metal when heated between 800 to 1,500 F. During welding, an area of parent metal alongside the weld will inevitably be heated into this range. Here chromium carbides will precipitate and the region will be "sensitive" to intergranular attack.

In many media such precipitated carbides do not limit the usefulness of the metal. In other cases they do. The villainous carbides can be banished by annealing after welding, which redissolves them in the matrix. However, in complex equipment, annealing is frequently out of the question. In such a case it may be desirable to use an extra-low-carbon grade.

It should be noted that the "L" grades are not completely immune to intergranular attack. It is possible for them to become susceptible after prolonged heating in the "sensitizing" range, especially at 1,000 to 1,300 F.

Generally speaking, Types 304L and CF-4 are used in moderate-to-severe media at service temperatures below the "sensitizing" range. Here Types 304 and CF-8 aren't quite good enough with respect to intergranular attack, and post-weld annealing is impractical.

Addition of molybdenum raises the corrosion resistance of the 18-8 type stainless in a variety of media (sulfurous acid, sulfuric acid, phosphoric acid, formic acid, and various hot organic acids). It makes the 18-8 type stainless useful at room temperature in sulfuric acid of concentrations up to 15%, and higher than 85%. It substantially increases resistance to pitting, which is particularly important in media containing halogen ions. It also imparts high-temperature strength.

As in the case of the molybdenum-free 18-8 grades, Type 316L is used instead of Type 316 where extensive welding is in order. Like Type 304L it resists harmful carbide precipitation from the welding heat but should not be used if service temperatures exceed 800 F. Type 317L is more corrosion resistant and less susceptible to intergranular attack than Type 316L.

▶**Resists Oxidation**—The low-carbon grades are similar in oxidation behavior to their higher-carbon counterparts.

In general, 304L has good oxidation resistance up to 1,700 F. However, for intermittent service, especially where cooling is rapid, a maximum temperature of 1,600 F. is suggested. The molybdenum-containing grades, 316L and 317L, are not as good as 304L, but are usually satisfactory up to 1,650 F. They deteriorate much more rapidly in a stagnant oxidizing atmosphere than in a free-flowing one.

▶**Sacrifice Strength** — As expected, the very-low-carbon 304L stainless steel is weaker than the higher carbon Type 304.

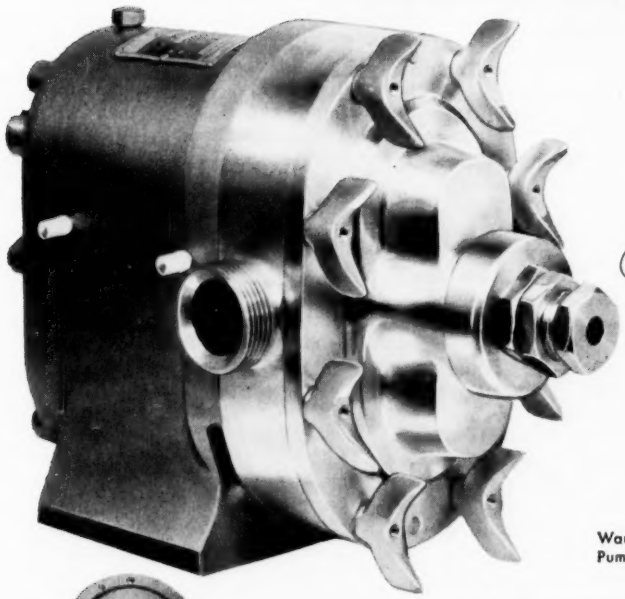
Average tensile strength is about 10,000 psi. lower, average yield strength about 5,000 psi. lower, while average percent elongation in 2 in. is about the same. Likewise, the low-carbon molybdenum-containing Type 316L is weaker than the higher-carbon Type 316. Average tensile strength of Type 316L is about 5,000 psi. lower, its average yield strength about 10,000 psi. lower, and its average elongation in 2 in. is about 5% higher. Strength properties of 317L are similar to those of 316L.

Available data indicate that the strength and ductility of the

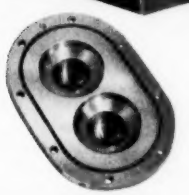
all WAUKESHA P.D.*
Corrosion-Resistant
PUMPS

grow up to be healthy active oldsters

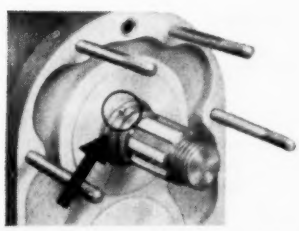
*Positive Displacement



Waukesha P.D. Sanitary Pump with Vented Cover.



Re-usable Oval Ring replaces fussy paper gaskets . . . provides positive vacuum without excessive tightening of the pump head.



Larger shaft and stronger splines reduce wear by giving high rigidity to the impellers. Slotted stainless steel shaft-sleeve keep sleeve and shaft rotating together.

WAUKESHA MODEL D.O. CORROSION-RESISTANT PUMPS grow old in service but stay young in performance. That's because WAUKESHA builds ruggedness and long life in them at the start. And they have many other virtues: quick, easy take-down, easy assembly and low maintenance, are examples. And the pump can be operated *without product flowing through it.*

The load on the impeller end of the shaft is close to the ball bearings to minimize shaft-slap and impeller wear . . . ball bearings are force lubricated; no oil in the chamber. Larger shafts, huskier splines provide rigidity for the impellers. And a stainless steel, slotted sleeve (reversible to double service-life), rotates with the shaft to relieve wear.

These are but a few of the many long-life features that make WAUKESHA far and away the leading rotary, corrosion-resistant, positive displacement pump in the world. Why not send today for the catalog that describes *all* the user-benefits?

Waukesha

FOUNDRY COMPANY

DEPT. U5 • WAUKESHA, WISCONSIN

very-low-carbon casting grades are about the same as those of their higher carbon counterparts, i.e., CF-8 and CF-8M.

Tests also show that creep strength of the extra-low-carbon wrought grades is somewhat lower than the average values for their higher-carbon counterparts in the 1,100 to 1,400 F. range.

Creep and rupture properties of the very-low-carbon casting alloys are about the same as those of their higher carbon types.

Generally speaking, the "L" grades are fabricated and heat treated in the same manner as their higher-carbon cousins. They are readily cold formed and welded. They are annealed by heating in the range of 1,850-2,000 F. followed by air cooling.

The extra-low-carbon grades are readily available in a wide variety of forms. This includes sheets and strip, bars, flats and plate, seamless and welded tubing, as well as a wide assortment of castings.

▶**Low Nickel, High Manganese**—The steels, Type 201, 202, 204 and 204L, are low nickel counterparts to the Type 300 series. They contain about 5% Ni, 9% Mn, and were developed during the nickel shortage. Two new types, CMN (Crucible Steel) and G-192 (Allegheny Ludlum) contain no nickel and are designed for high-temperature.

Alloy CMN contains 0.65% C, 12% Mn, 25% Cr and 0.45% N. Alloy G-192 contains about 0.60% C, 9% Mn, 22% Cr and 0.35% N.

In most cases the Type 200 series alloys are very similar to 300 stainless steels in mechanical properties and corrosion resistance (see table). CMN was actually developed for use as rider-sheets in annealing furnaces, where it is a good substitute for Types 310 and 446. Alloy G-192 was intended primarily for exhaust valves in internal combustion engines.

▶**New Stabilized Grades** — If equipment is complicated and assembly by welding requires keeping it hot for some time, or the equipment is used in the "sensitizing" range, then you should consider using a columbium or titanium-stabilized stainless.

New Grades of Stabilized Stainless Steels (% Comp.)

	Type 318	Type 309C	Type 310C
Cr	17–19	22–24	24–26
Ni	13–15	12–15	19–22
C	0.08 max.	0.10 max.	0.10 max.
Mn	2.50 max.	2.0 max.	2.0 max.
Si	1.0 max.	1.0 max.	1.5 max.
Cb,Ta	10 x C	10 x C	10 x C
Mo	2–2.57	.....	.....

Stainless stabilized grades, have been used widely to prevent intergranular corrosive attack, at temperatures in the range of 900 to 1,600 F, as well as for welded construction.

However, until recently these have been available only in the so-called 18-8 grades, that is, Types 321 and 347. In the past few years, the more highly alloyed austenitic stainless steels such as 23Cr-13Ni (Type 309), 25Cr-20Ni (Type 310), and the molybdenum-bearing 18Cr-13Ni (Type 316) have become available in stabilized grades. These new steels are stabilized exclusively with columbium or columbium plus tantalum. Titanium is seldom used. Compositions are given in the table above.

In addition, demands of the atomic power industry have resulted in a modification of Type 347 stainless. The standard grade contains columbium and tantalum. Because of the adverse effects of tantalum in atomic energy, the new steel, Type 348 contains 0.1% max. tantalum.

▶**Good Mechanical Properties**—These new steels have mechanical properties, at both room and elevated temperatures, essentially the same as the corresponding unstabilized grades. The columbium additions, however, result in somewhat improved elevated-temperature creep and rupture properties.

The new steels are essentially austenitic and nonmagnetic, although Type 309C may contain a small amount of delta ferrite and, thus, will be slightly magnetic.

These grades are all available in plate, bar, sheet and strip form.

▶**Good Corrosion Resistance**—These steels were designed to have the excellent corrosion resistance of their unstabilized counterparts. In addition, they can be welded without subsequent heat treatment, and used at temperatures where, because of intergranular carbide precipitation, the unstabilized grades cannot be used. Reference to the standard corrosion tables for Type 347, 309, and 316 will indicate the extent to which the stabilized grades resist attack in various corrosive media.

The new steels also have the oxidation resistance of their unstabilized counterparts.

▶**No Fabricating Problems** — Stabilized grades are readily cut by the methods commonly used on mild steel—abrasive disk cutting, sawing, and oxy-acetylene flame cutting. In machining, they are inclined to be gummy and to tear as do the other austenitic stainless steels. Machining practices used for Type 302 will suffice.

As annealed, these new materials are quite soft and readily formable. Deep forming operations can usually be accomplished with no intermediate annealing.

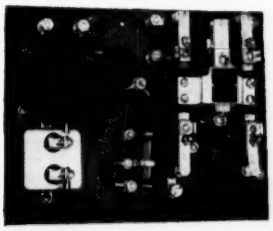
The alloys cannot be hardened by heat treatment. They can be stress relieved by heating at 1,500 F. for a few hours with no fear of susceptibility to intergranular attack.

Types 318 and 348 are normally annealed in the range of 1,800 to 2,000 F., whereas Types 309C and 310C are annealed in the range of 1,950 to 2,150 F. Care must be exercised to insure that a temperature of 2,150 F is not exceeded since this may subsequently impair resistance to intergranular attack.

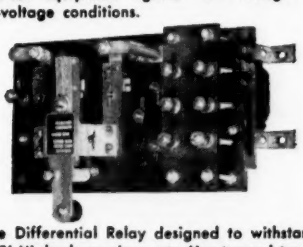
All these alloys are readily weldable by conventional welding methods. Stabilized welding rod is available to insure a completely stabilized welded structure.

Because of the somewhat higher cost of stabilized grades, applications are usually restricted: where annealing after welding is not feasible, or where it's necessary to have complete freedom from intergranular attack due to operation at temperatures of 800-1,500 F. Consequently, these are normally used in large welded structures operating at elevated temperatures in severely corrosive environments.

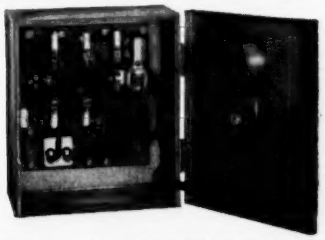
ASCO close differential relays respond crisply to 2% voltage or current variations... with no chattering on pickup or dropout.



Voltage Type Close Differential Relay protects electrical equipment against low voltage or over-voltage conditions.



Close Differential Relay designed to withstand NAVY Hi-shock requirements. Has tapped transformer making the relay suitable for a series of different pickup and dropout voltages.



Current type Close Differential Relay Panel for process control. (Relay operates as a function of motor load current.) Has adjustable pickup and dropout control. Panel has been used successfully for controlling cotton baling equipment.

ASCO Close Differential Relays (available either A-C or D-C) have been developed to meet the demand for a unit having the ruggedness of a power relay yet retaining the sensitivity of a primary control relay.

FEATURES

• Positive action on make or break, with no tendency to creep on opening or closing • 2% Sensitivity • Wide Variety of Applications • Available in Various Pole Combinations Up To 2 Normally Open and 2 Normally Closed Poles • Continuously Adjustable Pickup, or Variable Pickup By Tap Changing is Available • Continuous Dropout Adjustment is Standard.

MODIFIED ARRANGEMENTS

• High Shock Design • Variable Pickup • Frequency Response • Delayed Action • D-C Relays Also Available.

APPLICATIONS

As Voltage Relays they are extensively used in power and lighting systems to protect electrical equipment against low voltage or over-voltage conditions. For example... they permit detection where motor feedback conditions would not permit detection by ordinary potential relays. These relays are regularly furnished with ASCO Transfer Switches to provide voltage supervision of single phase and polyphase systems.

As Current Relays they have found extensive application as off-peak load relays to automatically disconnect selected loads, preventing system loading beyond set values. Close differential detection makes ASCO Close Differential Relays ideal for process control by motor current measurements.

Close Differential Relays are only part of the complete line of Relays offered by ASCO. ASCO Catalog 57-S4 lists:

• MAGNETICALLY HELD RELAYS
AC or DC . . . Normally Open . . . Normally Closed . . . Double Throw
• MECHANICALLY HELD RELAYS
AC or DC . . . All pole combinations

• SPECIALIZED RELAYS, INCLUDING:
. . . Reverse Current
. . . Time Delay
. . . Brake Winding Time Delay
. . . Close Differential
. . . Current Type, Welding
. . . Electronic
. . . Modified Arrangements

VISIT US AT THE DESIGN ENGINEERING SHOW BOOTHS 481, 483 AND 485

Write for your copy of "Relays by ASCO"— Catalog 57-S4.

Automatic Switch Co.
50-D Hanover Road, Florham Park, New Jersey
FRontier 7-4600

ASCO

Struthers Wells

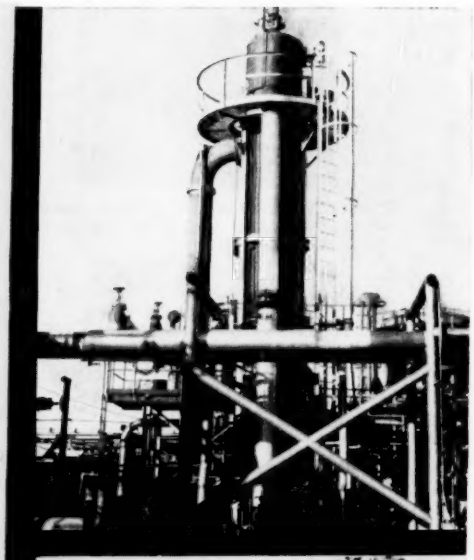
waste heat boilers steam generators

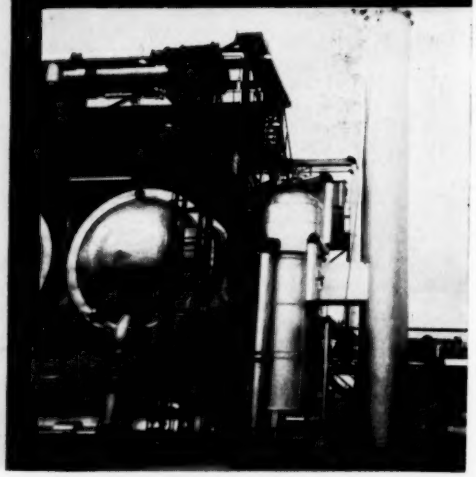
Struthers Wells offers a standard line of Waste Heat Boilers for the recovery of heat from gases and liquids. Four basic types are supplied, to handle a wide range of pressure and temperature, and for special process requirements.

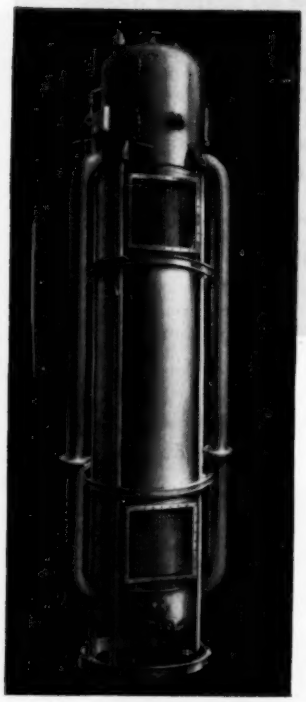
The Struthers Wells WV unit illustrated is designed to recover heat from gas turbine exhaust, high temperature catalytic reactors, and for many other services.

A number of large units are in service for leading chemical and petrochemical companies. The application photos show typical field views; the bottom photo showing one of two units installed for cooling gases from dehydrogenation reactors at a butadiene plant. The upper photo shows one of four units installed in a chemical plant.

If heat is available in high temperature gases or liquids, we will be glad to recommend and quote on equipment for steam generation at the required pressure.







Write!

Bulletin A-60 describes this equipment and is available on request.

STRUTHERS WELLS CORPORATION

WARREN, PENNA.

Plants at Warren and Titusville, Pa.

Struthers Wells

STRUTHERS WELLS PRODUCTS

PROCESSING EQUIPMENT DIVISION

Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

BOILER DIVISION

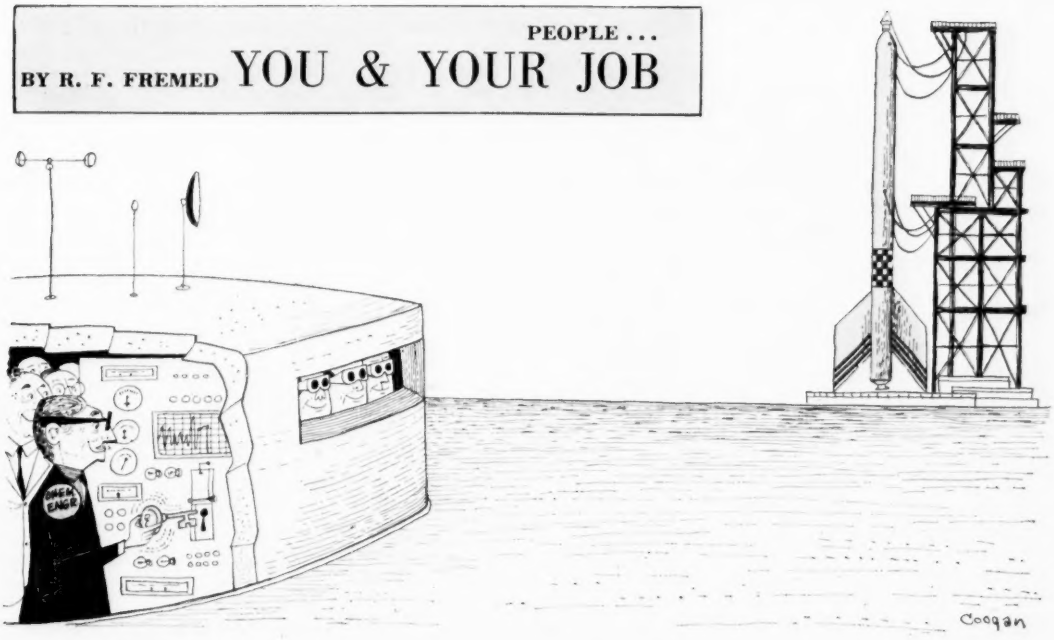
BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

FORGE DIVISION

Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

PEOPLE . . .

BY R. F. FREMED YOU & YOUR JOB



You Have a Key Spot in the Rocket Age

"In general, all branches of engineering make a solid-rocket team. But if you take a head count you'll find that chemical engineers are in the majority."

The chemist has become a very important scientist in the rocket age; and the chemical engineer has become a very important engineer.

In the field of solid-propellant rockets they enjoy a prominence akin to that accorded physicists in the Atomic Age. In liquid-propellant rockets, they face a growing future, especially in exploring new frontiers in rocket fuels and propulsion systems.

Yet, the surprising thing is that chemists and chemical engineers themselves don't seem to realize their importance to the rocket industry.

The result: an apparent critical shortage of chemists and chemical engineers in an activity vital to our nation's defense.

Perhaps no one is more aware of this state of affairs than Dr. Karl Klager, Manager, Solid-Propellant Development Div., of Aerojet - General Corporation's rocket facilities near Sacramento, Calif.* Brought here as a German rocket scientist after World War II, Dr. Klager now directs work in the multimillion-dollar Aerojet facility. Here, work is now going on developing such prime missile power plants as the rockets for the Navy Polaris.

One Out of Four

"In the solid-propellant rocket field," Dr. Klager says, "one out of four persons must be a chemist, chemical engineer or have some kind of chemical training.

"In liquid-propellant engines, the proportion is not as high but the need is still great."

Klager frequently makes a swing of eastern and midwestern industrial centers to recruit needed chemical talent. "When I go out on a hiring trip, I get skeptical treatment from prospects.

"Chemical people I talk to tell me that rocketry sounds interesting but that they don't want to quit their present jobs to become specialists in an industry which will fold after the current government interest in rockets subsides. They are afraid they will be left high and dry in five years and—worse than that—completely out of touch with the main body of chemical technology.

"I tell them: You fellows don't know what you are talking about. Chemistry in the rocket field covers a much wider field than you would ever imagine."

Covers a Broad Field

Activity in rockets and missiles covers the range from analytical to synthetic chemistry

* Meet Dr. Klager on p. 203.

and from physical chemistry, rheology and thermodynamics to a wide field of polymer chemistry; and covers the broad field of process engineering.

In addition you are required to have some understanding of other branches of technology such as mechanical engineering, stationary testing and interior ballistics.

Rocketry can be ultimately defined as the conversion of chemical energy into mechanical motion. Since large quantities of chemicals are consumed in this process, the chemical engineer has a great stake in the rocket industry, if only as a supplier of basic materials.

The Future Challenges

Since commercially available chemicals are now being used as propellants, the role of the chemist and chemical engineer may not immediately appear to be a challenging one.

However, while dealing with today's chemicals a great amount of work is going into corrosion research, studies on the storability of fuels and oxidizers, studies on the rate of decomposition of materials, behavior of chemicals under rapid acceleration or under adiabatic compression, the influence of low and high temperatures on both fuel and oxidizer and the ignitability of the propellant under adverse conditions.

Over and above the use of commercially available chemicals, the rocket designers are asking for more and more thrust from the same payload of chemicals. Here, chemists have found new syntheses and chemical engineers have succeeded in scaling up to production of new propellants in million-lb. quantities.

Significant in Solids

The role of the chemically trained man in the solid-rocket industry is especially significant.

The system, fuel-and-oxidizer, is obviously best only when the ratio of combustible elements to available oxygen is close to the stoichiometric composition. This, in turn, poses the problem of working with highly filled polymeric materials (70-90%), which must have mechanical properties suitable for the specific application. Furthermore, the monomers yielding products must be selected so that they have the required ballistic and mechanical properties.

If such monomers are not available commercially, the chemists and chemical engineers must supply them, test them and interest industry in producing the material in quantity.

Process study and scale-up is again in the hands of the chemical engineer, who has developed ingenious methods for reproducibility to meet the accuracy required for the application.

Use of solid-rocket engines increases over a broader and broader range of applications, as solid-rocket designs call for higher energy release from the same weight. Chemists and chemical engineers have the challenging task of pushing back the frontiers of chemical and engineering knowledge to achieve still higher performance. As one result of this, vast numbers of new chemicals have been prepared and characterized with future applications in fields other than rocketry.

You Are a Key Man

From the foregoing discussion, you can see that you are a key man in America's fast-growing missile effort. This is an industry that gives a rare opportunity to explore new frontiers of the profession. It also affords the man some chance to work in an area of great scientific value, versatility and universality, including rocket research, development, application and process engineering.

Tongue in cheek, Dr. Klager explains that the great need in rocket chemistry today is for a "man 25 years old with a Ph. D., plus 15 years of experience."

Seriously though, he said his firm is spending many thousands of dollars to attract top-rate chemists and chemical engineers to its Sacramento, Calif. plants.

Salaries: At Least as Good

"One question I am often asked," he said, "is how the salaries compare with other industries."

This is Dr. Klager's standard reply:

"Starting salaries are on a plane with other industries, but the chances for increase and advances are much better because this is a young and dynamic industry. It is here to stay, and as it expands, there are more and more openings in executive positions."

Majority Are Chemical

Since Dr. Klager is primarily a chemist, we asked Emil Mikity, *CE's* Western Editor in San Francisco to stop in at Aerojet-General and ask some more specific questions about the place of chemical engineers in the rocket age.

Dr. Ernest R. Roberts, Manager, Solid Rocket Research and Development, was kind enough to give us some answers:

"We use chemical engineers in practically every facet of our organization. In our study groups—which work on the more abstract and theoretical problems—we use the background possessed by chemical engineers in heat transfer and thermodynamics. In our preliminary design activities we lean on their background which qualifies them to work on internal ballistics problems.

"In development, we rely on their background for evolving the steps for processing of propellants. In production, this again involves engineering work in relation to propellant processing and rocket-motor processing. Engineers, too, play an important role in setting up our pilot plants or pilot-production facilities.

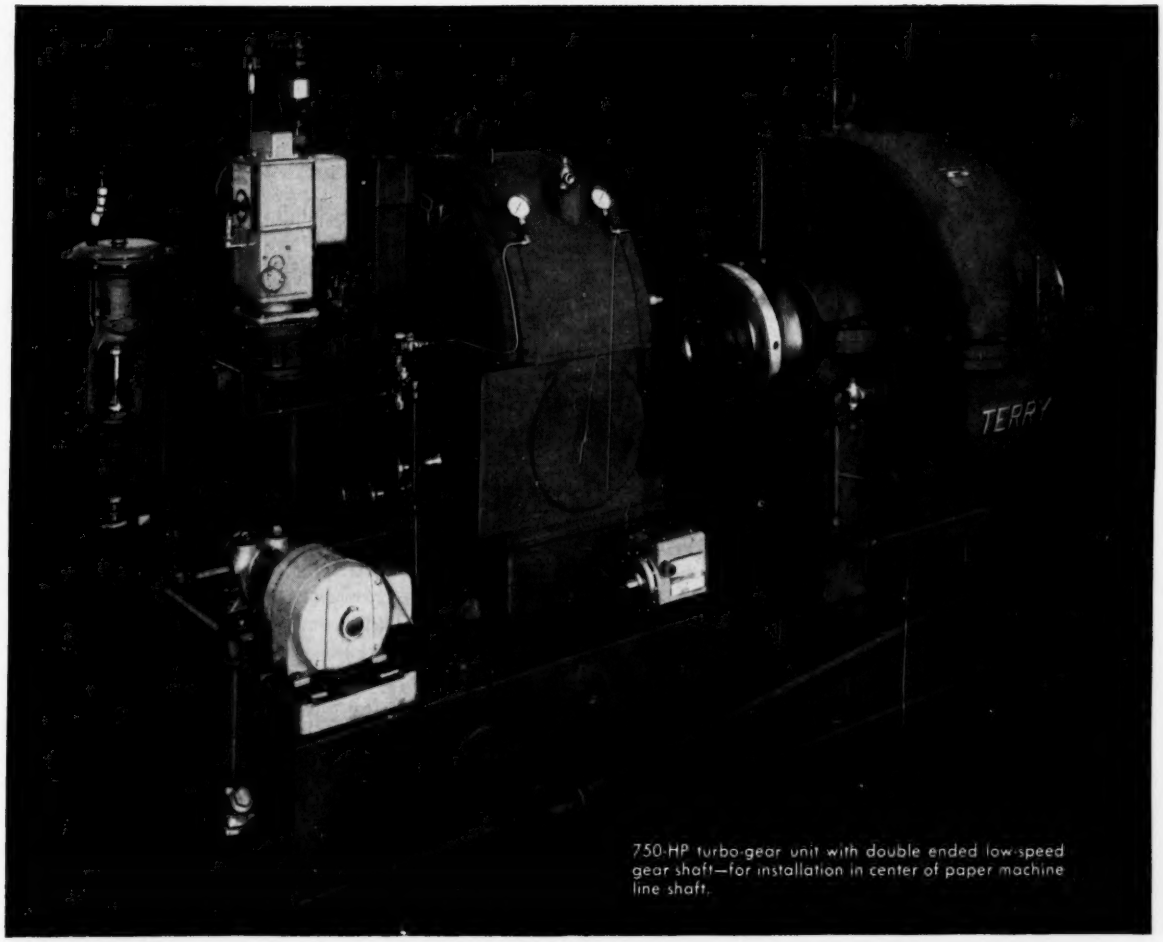
"In general, all of engineering operations are team efforts with chemical engineers working along with other types of engineers.

"But if you make a head count in these teams in the solid-rocket plant, you will find that a majority are chemical engineers."

Next Issue

What you told us about the "Shortage of Engineers."

First and EXCLUSIVE results from a survey of 2,000 outstanding chemical engineers.



750-HP turbo-gear unit with double ended low-speed gear shaft—for installation in center of paper machine line shaft.

LOW-SPEED TURBINE DRIVES

tailored to meet your requirements

For more than half a century, Terry has been one of the principal suppliers of turbo-gear units for driving slow-speed fans, generators, paper machines, large pumps and the like. Each unit is designed to meet the job requirements. The paper-machine drive illustrated is a good example of this *individualized engineering.*

In service at a large southeastern paper mill, the unit delivers 750 HP at 3350/500 RPM, with steam conditions of 450 lbs., 660°F and 50 lbs. back pressure. Equipped with a variable-speed governor, operated by remote control, the speed of the unit may be varied through a 10:1 range. Other features include forced-feed lubrication to turbine and gear bearings, and automatic shutdown and alarm in case of low oil pressure.

Whatever *your* requirements for low-speed turbine drives, a Terry engineer will be pleased to discuss them with you. Bulletin S-140 covers the full line of Terry turbines; Terry gears are described in bulletin S-130.

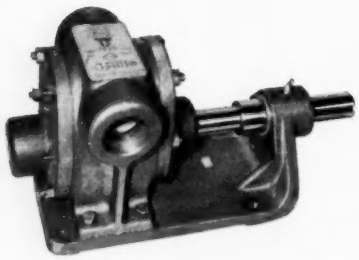
THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1212

GAULIN

Twin-Lobe* P.D. Pumps Provide High Efficiency on Wide Range of Products



Manton-Gaulin presents a completely new concept in rotary positive displacement pumping — The Gaulin Twin-Lobe*® design.

Unusual simplicity and extremely efficient performance are the results of a special "Twin-Lobe" pumping principle. These are the advantages:

- Simple construction, only three moving parts.
- High mechanical efficiency, lower horsepower required.
- High vacuum, self-priming. Efficient enough to move volatile gases or extremely viscous liquids.
- Wide range of uses and built-in corrosion resistance.
- Special materials used throughout for long wear, precision fit.

One Basic Design Good for Many Uses

Highly efficient Twin-Lobe design for transfer and metering of liquids, heavy slurries, pastes, soft food solids, gases, and light non-lubricating liquids.

Capacity and Pressure Range

Three models now available. Capacities: 0-56 gpm; Pressures: 0-200 psi.

Send for New Bulletin!

Find out how the new Twin-Lobe pump can save money, improve efficiency of transfer and metering.

*Pat. Pending

Gaulin TRADE MARK

MANTON Gaulin MANUFACTURING CO. INC. EVERETT, MASS.

71 Garden Street, Everett 49, Mass.

World's largest manufacturer of stainless steel reciprocating, positive displacement, pressure exchange pumps, dispersers, homogenizers and colloid mills.

PEOPLE . . .

FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES

This Month's Top Projects:

Riverside-Arizona Cement Co. is starting construction this month on a 1.5-million-bbl./yr. cement plant in Clarkdale, Ariz. Raw material reserves at the site are said to be sufficient for centuries of plant operation, even at doubled capacity. Production of finished cement is expected before close of 1959.

Transwestern Pipeline Co. has filed application with Federal Power Commission to authorize Transwestern to build a 1,305-mi. pipeline system from natural gas producing areas of West Texas and Texas-Oklahoma Panhandle to the California-Arizona border. The $193-million pipeline will enable firm to deliver 350 million cu. ft./day of 700 psi. gas to its sole customer—Pacific Lighting Gas Supply Co.

Kolker Chemical Corp. is planning to erect a 15-million-lb./yr. phthalic anhydride unit at its Newark, N. J., plant. Completion is slated for end of 1958.

West Virginia Pulp & Paper Co. is moving ahead with its projected $50-million rebuilding program at its Luke, Md., pulp mill despite depressed business. Plans will add 750 tons/day to capacity in next five years.

Catalytic Construction Co. of Philadelphia has landed the general construction contract for erection of Goodyear's new $9-million Videne film plant at Apple Grove, W. Va.

Chemetron Corp. (formerly National Cylinder Gas) has completed a plant expansion at Kansas City, Kansas, that doubles production capacity for commercial hydrogen. Increase will keep pace with area's industries—especially electronics, power companies and chemical processors.

Dravo Corp. is completing construction of a new intake and pump house that can supply 100 million gal./day for Union Carbide Chemicals' expanded activities at Institute, W. Va. Water supply comes from nearby Kanawha River.

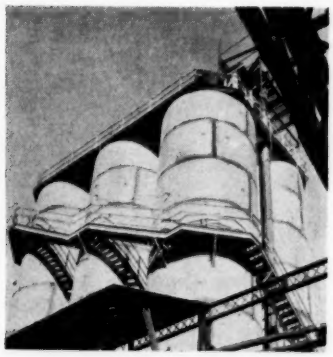
Columbia Western Corp. has selected Hanna, Wyo., as the site for its new $1.8-million coal-carbonization plant. Startup is scheduled for Aug. 1959.

Mead Corp.'s Chillicothe, Ohio, Div. is planning a new color coatings plant for its Chillicothe manufacturing complex. Output will go into production of tinted paper; estimated completion date is early 1959.

Metal & Thermit Corp. has officially opened its new organometallic chemical manufacturing plant in Carrollton, Ky., increasing its sales potential by one third. The $3.5-million installation will produce about 2.5 million lb. annually of organotin compounds for use in such end-

products as vinyl plastics, rubber and biocidal and fungicidal agents.

Alan Wood Steel Co. has moved up the target completion date of its 50-ton/day iron powder plant to early 1959. The "H-Iron" process used in this plant will be the first time a fluid bed has been used for direct reduction of iron ore on a commercial scale.



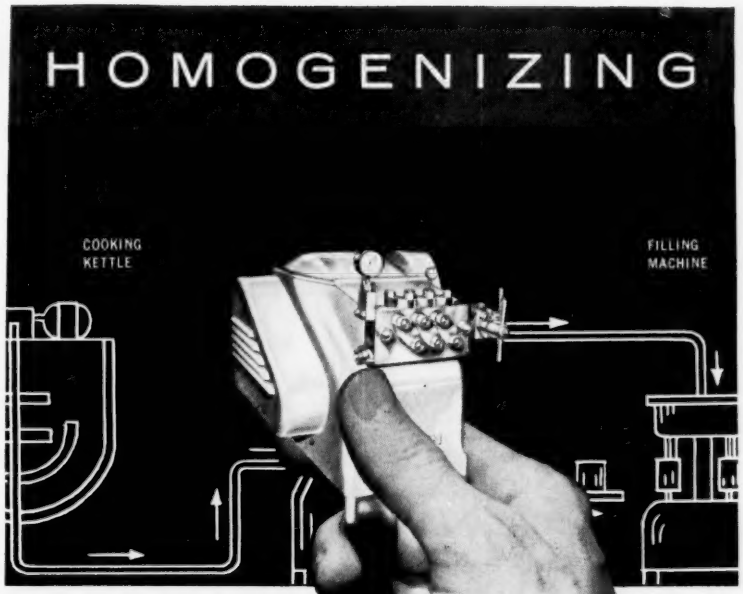
Olin Mathieson announces that it has completed new facilities at Saltville, Va., to produce and store dense soda ash; cost was more than $1 million. Addition of dense soda ash facilities will meet current and future demands of the glass industry.

Flintkote Co. plans to expand production capacity of its subsidiary, Kosmos Portland Cement Co., by 45%. When completed by middle of 1959, the expanded Louisville, Ky., plant will turn out 3.2 million bbl./yr.

Polymer Corp. Ltd. will build a diversified hydrocarbon pilot unit at its Sarnia, Ont., plant to test stereospecific catalysts for new hydrocarbon rubbers. Cost of the unit will exceed $500,000; firm is also finishing up a $1.2-million addition to its research and development labs.

El Paso Natural Gas Corp. is drawing up plans for a $5-million gas processing plant at Opal, Wyo., that will strip propane and natural gasoline from wet gas. Fluor Corp. is

HOMOGENIZING



Dramatic Money-saving approach to blending, dispersing, emulsifying

Some Typical Applications of GTA

Wax emulsions
Resin emulsions
Pigment dispersion
Adhesives
Fat emulsions
Experimental coating colors
Chemical reactions
Pharmaceuticals
Dope dyeing
Light ink dispersions
Leather finish
Carbon black dispersion
Vinyl-pigment dispersions
Grease and petroleum production
Suspensions
Cosmetic and hand cream blending
Soap processing
Latex compounding

Gaulin *Particle Control* . . . plus GTA . . . gives you the *right* answer on the most inexpensive method to disperse, emulsify or blend your product.

- Homogenizers in GTA Bulletin H-55.
- Sub-Micron Dispersers in GTA Bulletin SMD-55.
- RE* Colloid Mills in GTA Bulletin C-57.
- Laboratory Homogenizers in GTA Bulletin LH-55.

GTA shows how to: Improve uniformity; stop separation; accent taste; improve texture; speed chemical reactions; reduce amount of materials needed; and easily control and duplicate your product.

It's easy to try Particle Control. Rent a Gaulin Laboratory Homogenizer or Colloid Mill for only $75.00 a month and see how your product can be made better, faster and cheaper.

Gaulin
MANTON Gaulin
MANUFACTURING CO. INC.
EVERETT, MASS.

71 Garden Street, Everett 49, Mass.

World's largest manufacturer of stainless steel reciprocating, rotary, pressure exchange pumps, dispersers, homogenizers and colloid mills

ANYTHING YOUR PROCESS EQUIPMENT CAN HANDLE--

metallo gaskets CAN HOLD!

Metallo Gaskets are manufactured as an integral part of your process system . . . to live with it . . . and last with it regardless of the chemical content and as long as it is in operation!

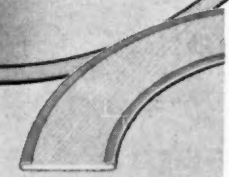
This is readily understood because Metallo standard Gaskets are fabricated to operate from vacuum to 30,000 psi, and from −320° F to + 2300° F—Metallo *Custom* Gaskets are designed to meet even severer operating conditions.

All Metallo Gaskets are made to seal readily and to endure the severest attacks of chemical deterioration. They are designed to withstand extreme pressure conditions, wide temperature ranges, accommodate expansion and contraction. They resist corrosive and errosive contaminants. They absorb shock, vibrations and minor misalignments. Yet—Metallo Gaskets conform to strictest performance requirements.

IMMEDIATE DELIVERY FROM STOCK

CUSTOM GASKETS GIVEN PROMPT ATTENTION

● See Our Catalog Pages in CEC Pages 1202 - 1203



METALLO STYLE 3

Single jacketed with .008 to .019 metal jacket enclosing one face and both edges. Filler can be asbestos millboard, sheet packing, rubber, teflon or as specified. These gaskets have a wide range of uses including air, ammonia, chemical, oil and steam lines. They are easily compressed, blow-out proof and resistant to temperatures up to 750 F.

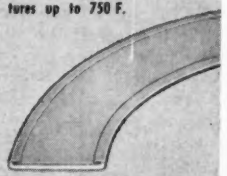
22 STANDARD STYLE GASKETS AVAILABLE

PRIMARY SOURCE FOR RASCHIG AND LESSIG RINGS

CONSULTING ENGINEERING AND DESIGN SERVICE AVAILABLE AT NO COST

NOW AVAILABLE!

New, comprehensive 20-page, 2-color catalog with complete information for all gaskets and other Metallo Products. Write to Dept. CE-2.



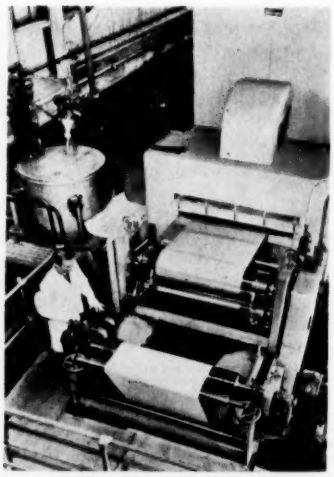
METALLO STYLE 4

Double jacketed with .008 to .019 metal jacket enclosing both faces and edges. Filler as specified. Recommended for high temperatures, pressures & severe working conditions. Added protection and strength of double metal jacket. Asbestos filler permits sufficient compression to insure efficient sealing of joints without strain on bolts.

metallo gasket co.

16 BETHANY ST. • NEW BRUNSWICK, N. J. • Kilmer 5-7223

handling design and construction; slated completion date is early 1959.



Richardson Co. has installed, at a cost of more than $250,000, a new phenolic saturator at its Melrose Park, Ill., plant. Unit, used in manufacture of laminated industrial plastics, processes rolls of base laminate material up to 50 in. wide.

Fibreboard Paper Products Corp., Antioch, Calif., will install a new half-million dollar off-machine coater that will be capable of applying a wide variety of coatings to paperboard in widths up to 92 in. and at speeds up to 1,000 ft./min.

NEW NAMES

Du Pont's Freon Products Div. has been renamed Fluoro Solvents & Chemicals section. New name, according to Du Pont, reflects increasing use of fluorinated hydrocarbons as solvents and chemical intermediates.

American Cyanamid has merged its Farm & Home and Phosphates & Nitrogen Div., calling new organization the Agricultural Div. Move will

streamline Cyanamid's expanding activity in agricultural field.

Philadelphia Gear Works, sixty-six-year-old maker of power transmission equipment, is changing its name to Philadelphia Gear Corp. effective June 1.

Metrix Corp. of Newton, Mass., has changed its name to Bytrex Corp. Firm manufactures strain gage devices and related systems.

Haloid Xerox, Inc., is the new corporate name of the Rochester, N. Y., firm formerly called the Haloid Co. Change comes about because of addition of Xerox copying products to firm's line.

NEW LINES

Reynolds Metal Co. is now producing superpure aluminum (99.99% purity) on a commercial basis. Used mainly in catalysts for petroleum industry, metal is being turned out in 7-lb. ingots.

Fisher Scientific Co. is now offering a new high-purity stabilized reagent-grade 50% hydrogen peroxide. New line should be of interest to both organic and inorganic chemists.

Dow has added allyl alcohol to its product line; volume production of this highly reactive chemical has started at Dow's Texas Div. Allyl alcohol is used as an intermediate in production of such things as resins, pharmaceuticals and flavorings.

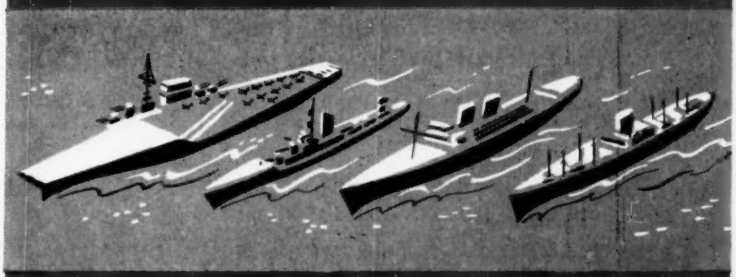
Hercules Powder Co. has formed a Chemical Propulsion Div. in its Explosives Dept. New division will engineer propulsion units for missiles and space vehicles on down to small, packaged power units.

BY WILLIAMS

CUPROUS OXIDE

for Navy Specification Shipbottom paints ... and other Marine Anti-fouling paints.

CO-97
CO-90



These two Cuprous Oxides — CO-97 and CO-90 — as made by Williams — meet all chemical and physical requirements of U. S. Navy Specification MIL-C-15169 (Ships) for Type I and Type II. They are produced in a modern plant especially designed to supply Navy demands during World War II.

	CO-97 (Type I)	CO-90 (Type II)
Cu_2O—Min.	97%	90%
Total Cu—Min.	88%	80%
Cl—Max.	0.4%	0.4%
SO_4—Max.	0.1%	0.1%
Acetone Sol.—Max.	0.5%	0.5%
HNO$_3$ Insol.—Max.	0.3%	1.0%
325 Mesh—Max.	0.5%	0.5%
Metallic Cu—Max.	1.0%	1.0%

NOTE: Also for fungicides, insecticides, and a reagent for catalytic work.

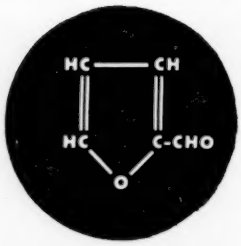
For complete information on prices, packages and samples, please get in touch with your nearest Williams representative, or write us direct.

Address Dept. 62 C. K. Williams & Co., 640 N. 13th Street, Easton, Pennsylvania.

WILLIAMS
CHEMICALS & PIGMENTS

E. St. Louis, Ill. • Easton, Penna.

PHYSICAL PROPERTIES OF QO® FURFURAL



GENERAL

Boiling point (at 744 mm), (Todd Still) °C.	160(98)%
Freezing point, °C.	−36.5
Refractive index (n 20/D)	1.524-7
Specific gravity, 20/20	1.161-3
Solubility in	
water (wt. % at 20°C.)	8.3
alcohol; ether	∞

FLUID PROPERTIES

Viscosity, cps. at 25° C.	1.49
at 38° C.	1.35
Surface tension, dynes/cm.	
at 30.0° C.	41.1
Vapor diffusion coefficient, $cm^2/sec.$	
at 25° C.	0.087

THERMODYNAMIC PROPERTIES

Heat of vaporization, $\triangle H_{433.8}$, kcal./mole	10.22
Thermal conductivity, B.T.U./(hr.) (sq.ft.) (°F. per ft.) at 100°F.	0.1525

For complete details on the physical properties of QO Furfural, write for Bulletin 203-A

The Quaker Oats Company

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The Quaker Oats Company — CHEMICALS DEPARTMENT — QO QUAKER CHEMICALS

CALENDAR

Air Pollution Control Assn., annual meeting, Sheraton Hotel.
May 25-29 Philadelphia, Pa.

Chemical Institute of Canada, 41st annual conference and exhibition, Royal York Hotel.
May 26-28 Toronto, Ont.

American Drug Manufacturers Assn., annual meeting, Greenbrier.
May 26-29 White Sulphur Springs, W. Va.

American Institute of Mining, Metallurgical and Petroleum Engineers, 3rd Annual Reactive Metals Conference, Hotel Statler.
May 27-29 Buffalo, N. Y.

Canadian Pulp and Paper Assn., Technical Section, summer meeting, Chateau Frontenac.
June 2-4 Quebec, P. Q.

American Nuclear Society, fourth annual meeting, Hotel Statler.
June 2-5 Los Angeles, Calif.

Armed Forces Chemical Assn., Hotel Traymore.
June 5-6 Atlantic City, N. J.

Fourth International Automation Exposition and Congress, Coliseum. **June 9-13** New York, N. Y.

Gordon Research Conference, Petroleum, Colby Junior College.
June 9-13 New London, N. H.

Gordon Research Conference, Metals at High Temperatures, New Hampton School.
June 9-13 New Hampton, N. H.

American Society of Mechanical Engineers, Materials Handling Conference and Exposition, Public Auditorium.
June 9-12 Cleveland, Ohio

Midwest Research Institute, symposium: Planned Experiments in Chemical Research, Hotel President.
June 11-12 Kansas City, Mo.

Manufacturing Chemists Assn., annual meeting, Greenbrier.
June 12-14 White Sulphur Springs, W. Va.

Chemical and Petroleum Exhibition, first annual exhibition in Britain.
June 18-28 Olympia, England

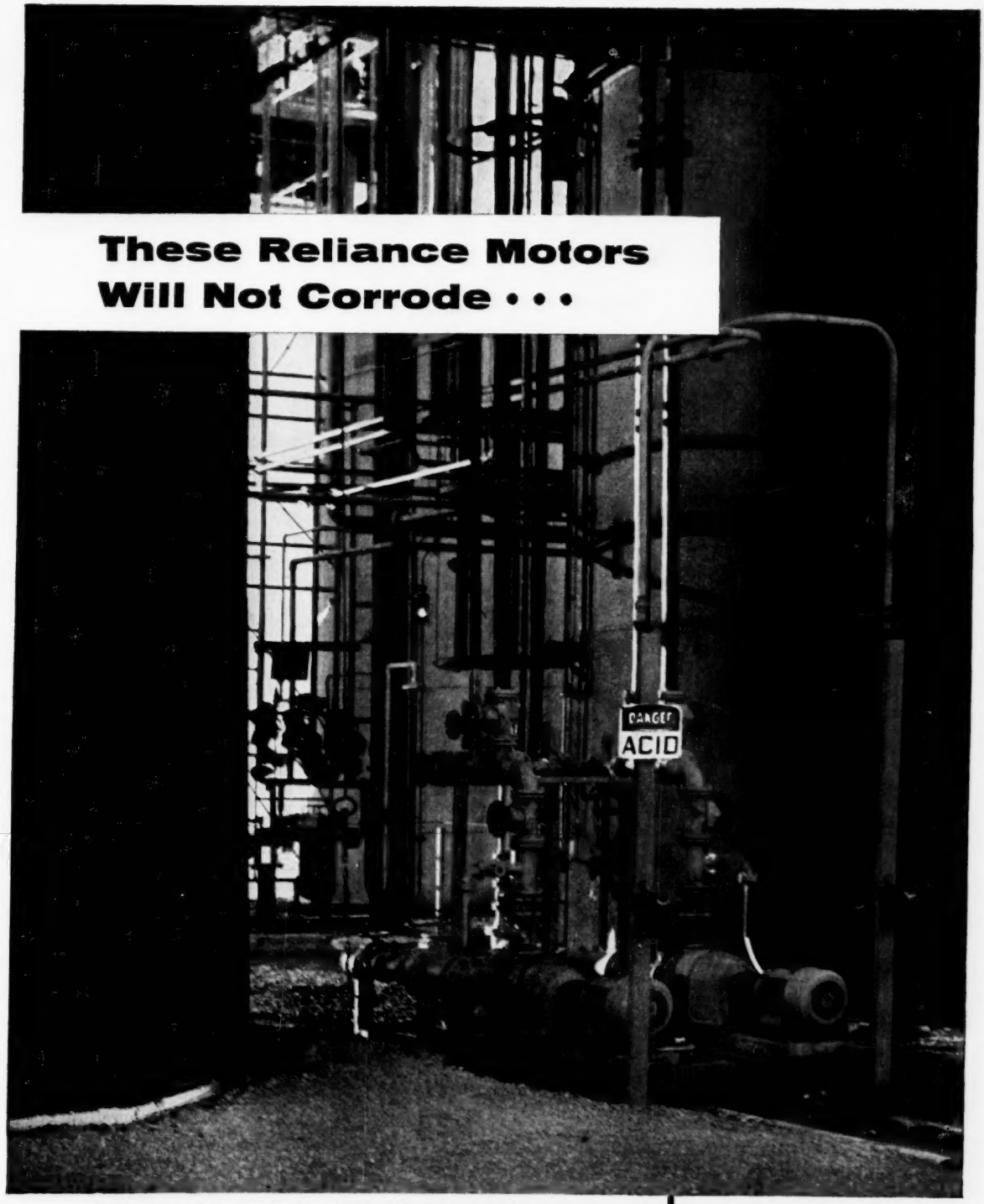
American Assn. of Cost Engineers, annual meeting, Case Institute of Technology.
June 16-18 Cleveland, Ohio

American Society of Mechanical Engineers, semiannual meeting, Hotel Statler.
June 15-19 Detroit, Mich.

Gordon Research Conference, Separation and Purification, Colby Junior College.
June 16-20 New London, N. H.

American Institute of Chemical Engineers, 50th Anniversary Meeting, Bellevue-Stratford Hotel.
June 22-27 **Philadelphia, Pa.**

American Society of Testing Materials, annual meeting and exhibition, Hotel Statler.
June 22-27 Boston, Mass.



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B-1572

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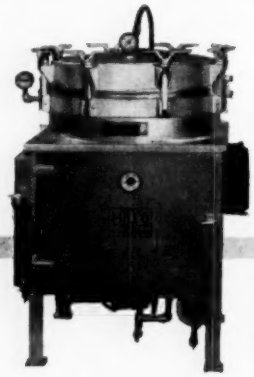

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PEOPLE . . .

TECHNICAL

Radioactivity for Laymen

RADIOISOTOPES — A NEW TOOL FOR INDUSTRY. By Sidney Jefferson. Philosophical Library, New York. 112 pages. $4.75.

Reviewed by E. S. Henley, Department of Chemical Engineering, Columbia University.

Jefferson's book has the stated purpose of "giving the layman an insight into the many and varied ways in which industry has benefitted and can benefit in the future from the use of radioactive material."

The book is definitely on a tissue-paper-will-stop-alpha-particles" level. In this respect it is competitive with the many atomic-energy-for-the-businessman-and-housewife books which have been published recently.

▶ **First the Caboose**—The first 60 pages are devoted to applications of isotopes, the last 49 explain the fundamental physics involved. Although this arrangement has some merit, it does put the caboose in front of the locomotive.

For instance, on page 55, Jefferson describes the uses of spent reactor fuel rods and fission products, but we must wait until page 62 before we are told in detail what an atomic reactor is.

▶ **Cogito, Ergo Neutrino?** — I was a bit surprised that Jefferson stated that there is no experimental proof for the existence of the neutrino. On this side of the ocean, we like to believe that the 1956 Experiments of Reines and Cowan at Los Alamos, and Davis at Brookhaven, were authoritative.

▶ **But, After All**—On the other hand, there is much to recommend the book. Some of the uses of tracers described are novel, and the descriptions are authoritative and detailed. Like most British texts, the book is lucidly and concisely written and will be of value to engineers who have had little or no contact with the Atomic Energy field.

BOOKSHELF

J. B. BACON

A Touch of Much

PLANT DESIGN AND ECONOMICS FOR CHEMICAL ENGINEERS. By M. S. Peters. McGraw-Hill Book Co. 511 pages. $11.

Reviewed by H. F. Wiegandt, School of Chemical and Metallurgical Engineering, Cornell University.

The objective of bringing together for students of chemical engineering concepts of costs, equipment design, plant layout, materials of construction, English composition, waste disposal, etc., is certainly desirable.

It represents a large share of the goals for the student. However, this reviewer questions the advisability of trying to cover this in 442 pages of text.

▶ **On the One Hand**—The result is a treatment which cannot more than touch many of the topics. Some examples of this are: patents, 3 pages; waste disposal, 7 pages; materials of construction, 14 pages; instrumentation, one-half page. Reactor design and furnaces, for example, are not mentioned. Unbalance also occurs: Bubble-cap tower design occupies 22 pages; sieve-plate construction, two paragraphs.

▶ **On the Other**—On the other hand, fluid flow and heat transfer are covered to a degree comparable with some current texts in unit operations.

▶ **And Yet**—Despite these comments, most chemical engineers should find this book of constructive value and, when used knowingly, a time-saver in numerous design problems. The book is remarkable in containing many pertinent and recent references to the literature.

BRIEFLY NOTED

BROMINE, ITS PROPERTIES AND USES. 62 *pp. Michigan Chemical Corp., 500 North Bankson St., St. Louis, Mich. Free.* Handily summarizes properties and uses of bromine, lists 506 literature references.

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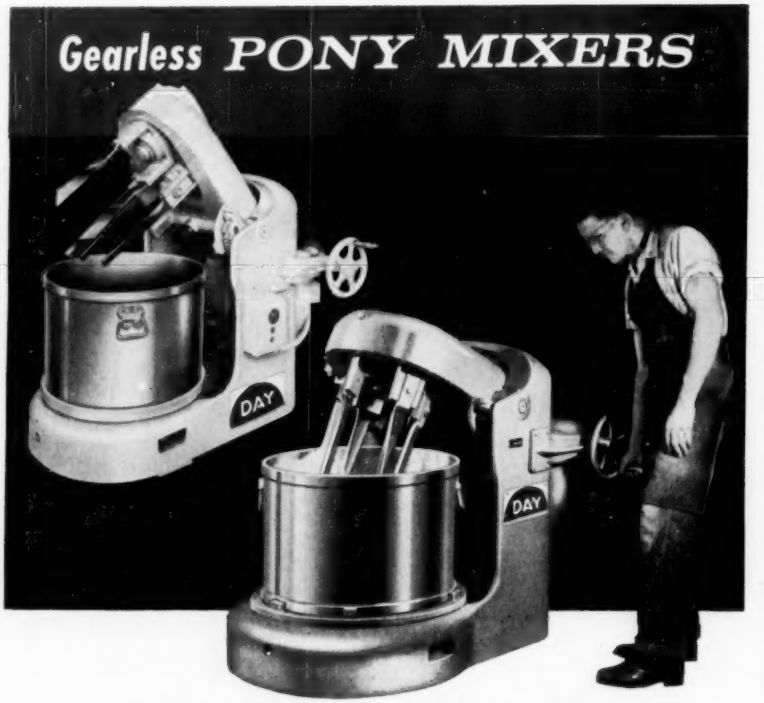

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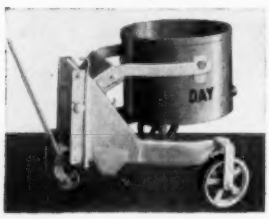

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PEOPLE . . .

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Robert L. Noland

Executive VP, Reinhold Engineering & Plastics Co.

One of the first to get knee-deep in rocketry, he's now on the top management team of a firm wrapped up in missile materials.

Back in 1942, when England was made painfully aware of what rocket technology could accomplish, a few young engineers in the United States were just getting their first glimpse of what a full-fledged rocket program would be like.

Among these young engineers was Robert Noland.

Noland had graduated the year before from California Institute of Technology, with a B. S. in engineering. Then, Caltech hired him in 1942 to take part in its rocket (NDRC) project—a project very much in the formative stages.

For the next three years, Noland worked as a design engineer on rockets and weapons. When he left the Caltech project, it had grown to a sturdy stage of development.

AUTHORS

M. A. GIBBONS

In 1945, he continued rocket work with the U. S. Naval Ordnance Test Station, at China Lake, Calif. Official post: supervisor of design.

After two years with the NOTS, he joined Aerojet-General Corp., where he took charge of design on rocket and JATO projects. For Aerojet, a leader in rocket development, he was tabbed principal design engineer —solid propellant rockets.

In 1952, Noland made his services available as an engineering consultant in the fields of rocketry and high-heat-resistant, high-strength plastic materials.

Two years later, he became associated with Reinhold Engineering & Plastics Co., Inc., as an engineer. Now, as vice president, engineering, he directs all engineering development activities. (The firm specializes in the use of asbestos, glass and silica type materials in the field of guided missiles.)

Noland is a member of the American Rocket Society and of the Society of Plastic Engineers.

Somewhat active in community affairs, too, Noland was formerly a member of the Monrovia-Duarte High School board of trustees and president of the Duarte, Calif., community chest.

G. P. Hammond

LET PHOTOGRAPHY SPEED YOUR DRAFTING. PAGE 161.

In collaboration with Co-author Richard Kinstler, Procter & Gamble's G. P. Hammond developed the unique photodraw-

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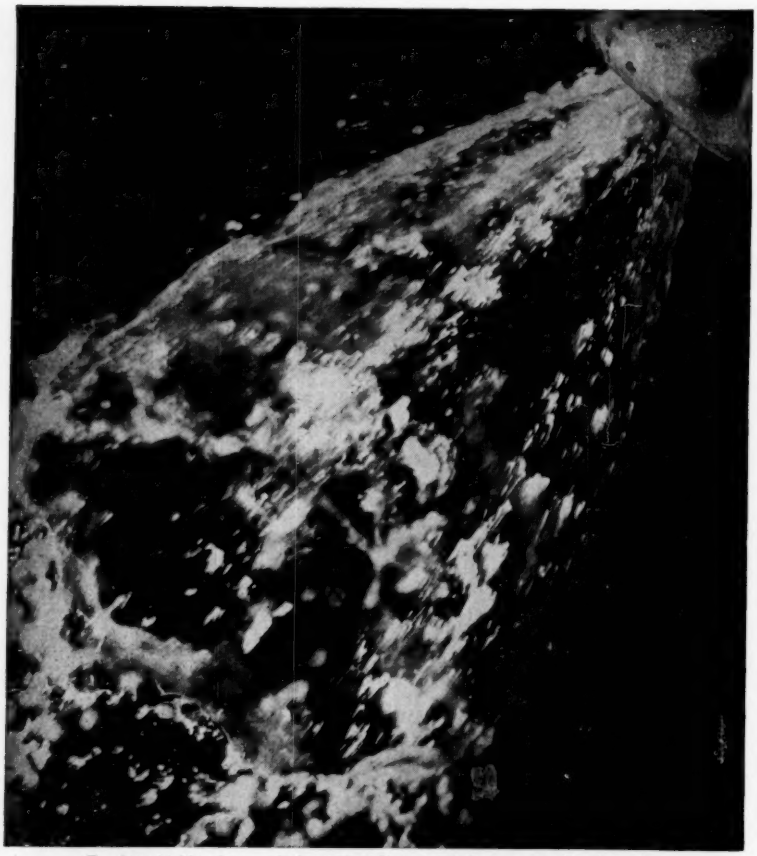

To show fluid volume, photographer Bernard Hoffman uses the free discharge of water from an ordinary garden hose.

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AUTHORS . . .

ing scheme outlined in this article.

Some years ago, Procter & Gamble Co. assigned Hammond to the task of developing new techniques for producing the drawings and specifications to communicate design intent to construction forces.

More recently, the firm also put him in charge of P & G's modeling shop where scale models of all new process facilities are built.

Ever since he joined P & G in the Fall of 1945, Hammond has handled engineering problems for the construction of new facilities. His early assignments included work on several new units in the post of project engineer.

Before joining P & G, Hammond worked for General Motors, the Detroit Diesel Division and the Naval Ordnance Laboratory. He studied at the University of Michigan where he earned a bachelor of science degree in mechanical engineering in 1943.

Hammond is a member of the Engineering Society of Cincinnati and is a member of Tau Beta Pi—dating from University of Michigan days.

Richard C. Kinstler

LET PHOTOGRAPHY SPEED YOUR DRAFTING. PAGE 161.

As manager of Procter & Gamble's photographic department, Richard Kinstler has a seasoned view of the best applications of photography as a tool in drafting.

In his post, Kinstler supervises sixteen employees, engaged in a broad range of photographic

applications to company operations in such areas as research and development, engineering, industrial relations, manufacturing, industrial engineering, administration, advertising and public relations.

In addition to the present article, Kinstler has authored many other articles and papers on technical applications of photography. Some of his work has been published in *Photographic Science and Technique* and *Industrial Photography* while he has presented many papers before the American Institute of Chemical Engineers and various professional photographic organizations.

One of our author's most ambitious works is a paper covering "The Role of Functional Photography in Industrial Communications."

Kinstler got his start in professional photography more than twenty years ago. For a while, he worked as a free-lance contributor to the press. Then, he turned to portrait work in a professional studio and handled a post as summer relief cameraman for the Cincinnati Enquirer.

In 1938, Kinstler became partner in a commercial and illustration studio. Three years later, he joined Wright Aeronautical Corp. as a junior metallurgist. Not long after, he became chief photographer in the experimental laboratory of the U. S. Navy Fleet Sonar School.

After the war, Kinstler joined Procter & Gamble as an industrial engineer. A year later, he organized the firm's central photographic department.

Kinstler was educated at the University of Cincinnati, where he earned a bachelor's degree in industrial management in 1951 —after a long siege in evening college. Just five years earlier, he had earned a certificate in business administration, also from the University of Cincinnati.

In 1955 and 1956, he served as chairman of the National Industrial Photographic Conference. Last year, he was elected to the board of directors of the Professional Photographers of America.

Kinstler makes his home in Cincinnati.

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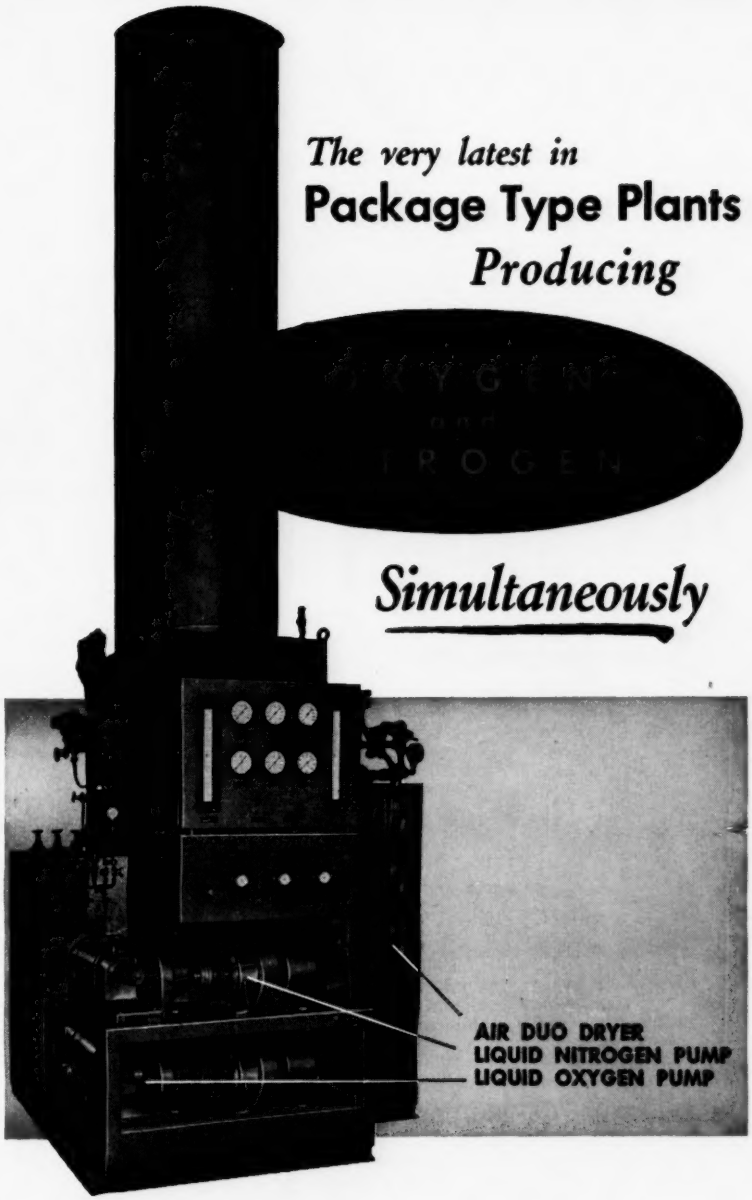

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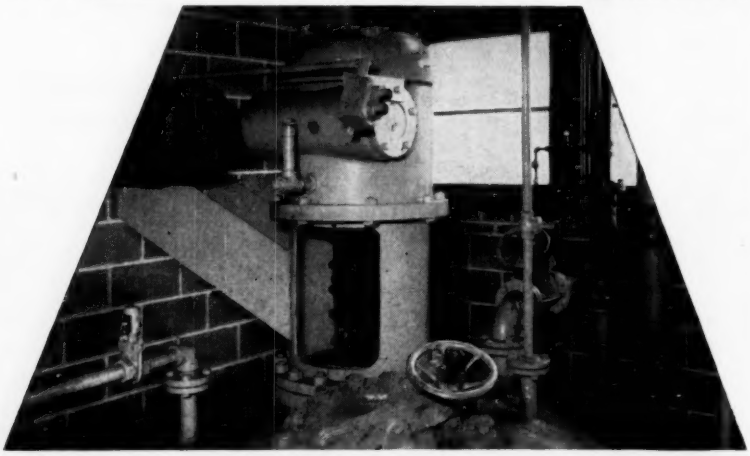

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AUTHORS . . .

Theodore M. Jenney

CHARTS GIVE YOU PERCENT CONVERSION IN EACH REACTOR STAGE. PAGE 166.

Author Theodore M. Jenney is a chemical engineer who specializes in process development.

Since 1955, he has been associated with the Becco Chemical Division, of Food Machinery & Chemical Corp., located in Buffalo, N. Y.

After graduation from high school in 1943, Jenney joined the Navy where he served in the Pacific area as an aviation navigator.

When he was discharged, he entered Ohio State University to study chemical engineering. He earned his bachelor's degree in 1949.

First job in the chemical engineering field was with Mathieson's research department (now Olin-Mathieson Chemical Corp.). He stayed on with Mathieson for six years, until he joined Becco.

Jenney takes full advantage of his home's locale in the Buffalo area. He says he spends free time "relaxing on the upper Niagara River—chasing fish from April till October and ducks from October till January."

His letter continues in a tone which would make any local chamber of commerce glow with pride:

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Karl Klager

Who Supplied Information for . . . YOU HAVE A KEY SPOT IN THE ROCKET AGE. PAGE 187.

Now an American citizen, Karl Klager is a native of Vienna, Austria. He came to the United States in 1949 at a time when many other outstanding German and Austrian scientists were being sought for their know-how in rocket technology.

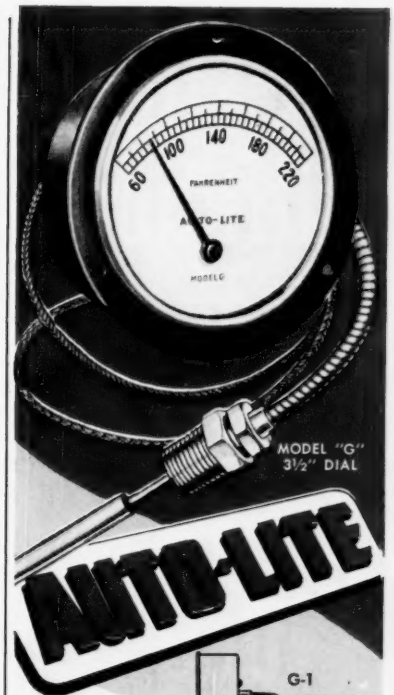
When he completed what he terms as a "short hitch as a paper clip contractor" for the Office of Naval Research, during 1949, he joined Aerojet-General Corp., a leader in rocket fuel development.

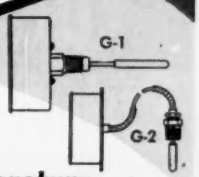
Klager is now manager of Aerojet's solid propellant development division, in Los Angeles, Calif.

In a field which challenges the chemical engineering prowess of most technical men, Klager is particularly well qualified to handle the job. Before taking on his present post with Aerojet in solid propellants, he worked on the development of both liquid and solid fuels. And, before coming to this country, he spent some ten years in the main research laboratory of I. G. Farbenindustrie working under Walter Reppe.

Technical background also includes training in the biochemical and pharmaceutical industries, in Rumania and Hungary, from 1934 until 1938. Klager is a graduate of the University of Vienna; he received his doctorate in 1934.

Professional memberships include the American Chemical Society, the American Rocket Society and the Research Society of America.





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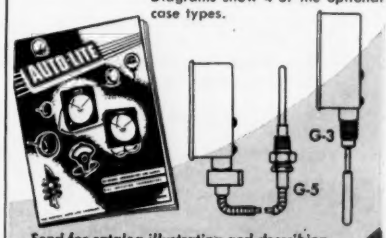

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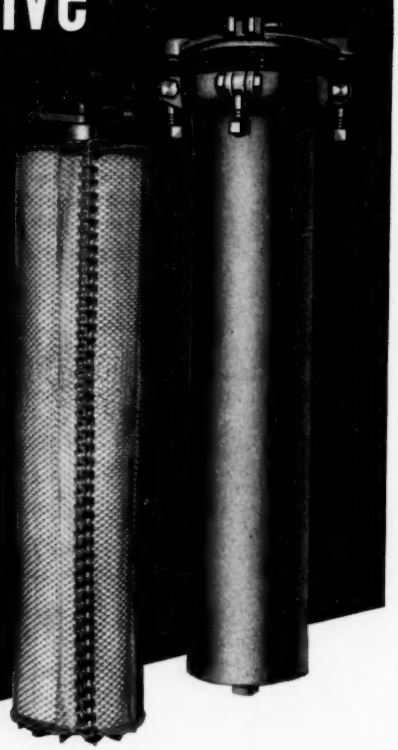

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PEOPLE . . .

LETTERS:

? R PROGRAMMING What

Con: Programming

Sir:

The Subcommittee for Spelling Programing With One M, part of a larger Committee for Publicizing the Rules for Doubling of Consonants, respectfully wishes to call your attention to the fact that the words *programing, programed* and *programer* are spelled correctly with only one *m*.

You are invited to join hands with Subcommittee members to prevent the acceptance of the hideous, misspelled word: *programming* (ugh!). Be strong. Do not waver when you are told that the British spell it with two *m*'s and that they have a prior claim to the English language. They have a right to use two *m*'s because their parent word, *programme,* also has two *m*'s.

Stand firm. Do not waver.

RONNY H. CORTES
Chairman, Both Committees
Long Beach, Calif.

According to Kipling

Sir:

Back in December you published a letter from I. H. Weissman (p. 344) suggesting that you compile a comprehensive decimal classification system for chemical engineering knowledge.

What a wonderful idea! All the technical journals print articles on processes, petrochemicals, pumps, polymers, prices, propylene, patents, pipelines, plastics, products and pollution, but nothing — BUT NOTHING—adequate on placement of material after you've collected it.

There is a crying need (that's me you hear crying) for an alphabetical subject classification. *Chemical Engineering*

PRO & CON

C. H. CHILTON

would be out in front by a furlong if every article carried its own classification in an upper corner! According to Rudyard Kipling:

"You must hack through much deposit
Ere you know for sure who was it
Came to burial with such honour in the Files."

CHARLIE S. RACHAL
Texas Butadiene & Chemical Corp.
Channelview, Tex.

Is Phytic Acid Digested?

Sir:

I have read with interest your story on phytic acid (Jan. 27, 1958, pp. 61-62). However, there is a gross error on its application.

Calcium phytate is never supposed to be used as a source of calcium and phosphorus in any pharmaceutical preparations. McCance and Widdowson (*Biochem. J.*, 29, 2694) and numerous other investigators proved that it is not digestible and cannot be utilized.

Since phytic acid and its salts are very powerful sequesterers, it is hard to justify their use in any food products, because they are taking away the nutritionally important minerals.

STASYS MAZILIAUSKAS
Mineral Chemical Co.
Boston, Mass.

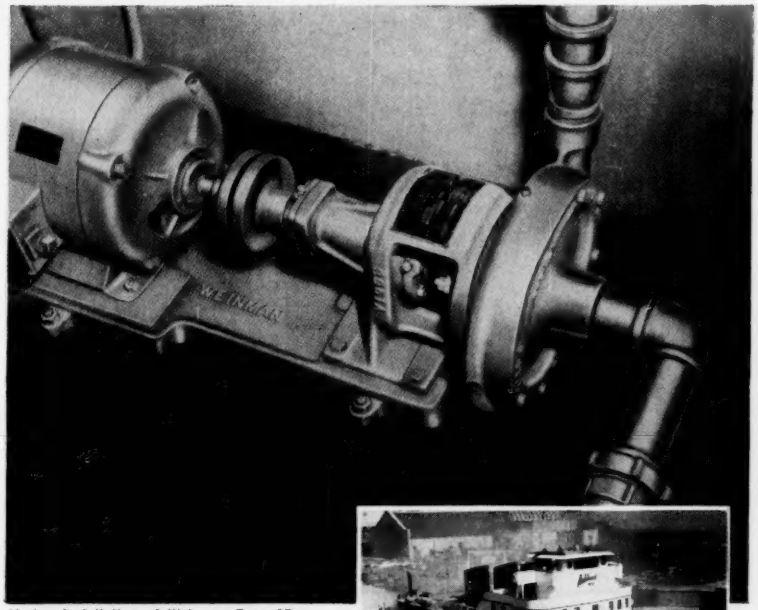
Sir:

This question is an interesting one, one in which many aspects might be cited in many references to support varying points of view.

Even in the McCance and Widdowson reference, it was found, using human subjects, that 20 to 60% of the ingested phytin was excreted unchanged. Suppose we look at it the other way; 40 to 80% *was* digested or utilized. This would not support the assertion that calcium phytate is not digestible and cannot be utilized.

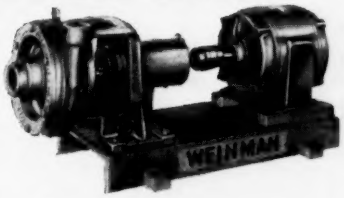
M. J. THOMAS
A. E. Staley Mfg. Co.
Decatur, Ill.

ONE WEINMAN TYPE GB PUMP INSTALLED...



Marine installation of Weinman Type GB pump on Allied-Ashland Oil Co. workboat.

all marine pumping worries over!



WEINMAN Type GB Frame Mounted, End Suction Pumps are *outstanding* for general service pumping. Practically unlimited in their fields of usefulness, they're favorites among engineers for many phases of liquid handling. Extremely compact, WEINMAN Type GB Pumps are specially useful where installation space is limited. Also, the discharge opening may be placed in any one of eight positions.

Available as a direct drive, motor operated unit, or with pulley for belt drive. Either type of drive performs efficiently, dependably, economically. Single stage; single suction; h.p. range, ½ to 50; heads to 260 feet; capacities to 2500 gpm.

Your nearby WEINMAN PUMPS SPECIALIST can give you full information on *all* WEINMAN Pumps. Call him . . . he's listed in the yellow pages of your phone book.

Write today for your free copy of WEINMAN'S *illustrated Bulletin 500, showing specifications, dimensions, construction features and complete selection table for* WEINMAN *Type GB Frame Mounted, End Suction Pumps.*

THE WEINMAN PUMP MFG CO
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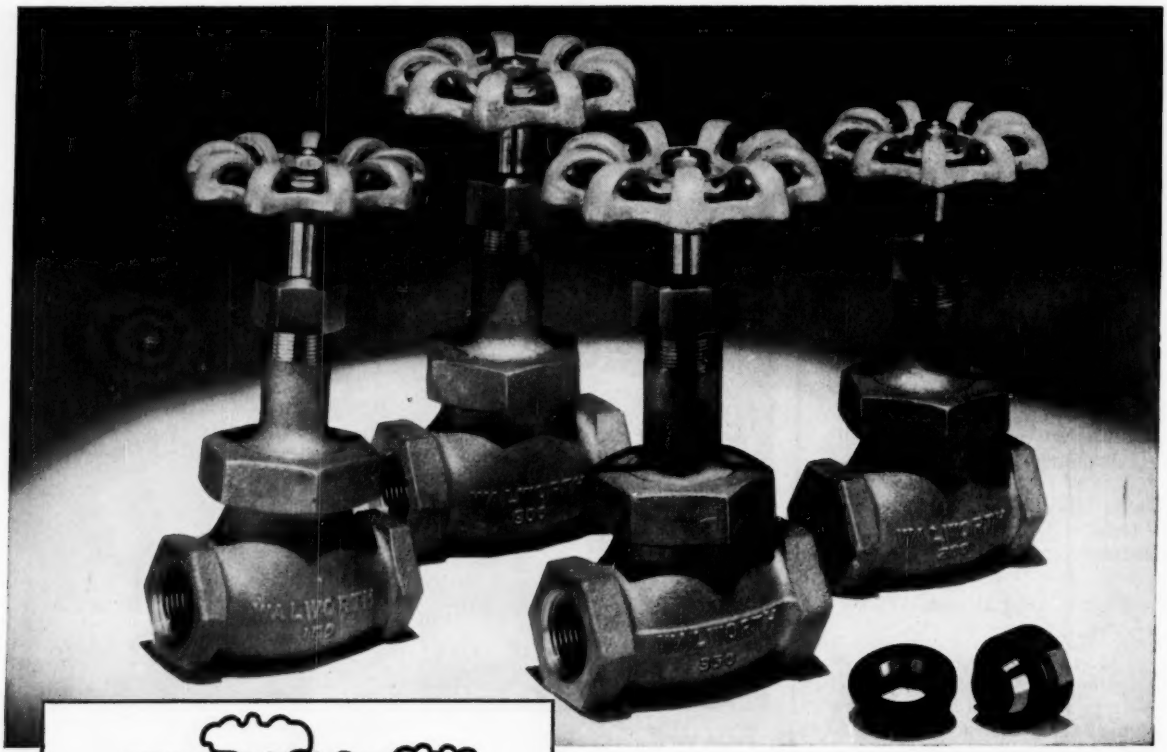
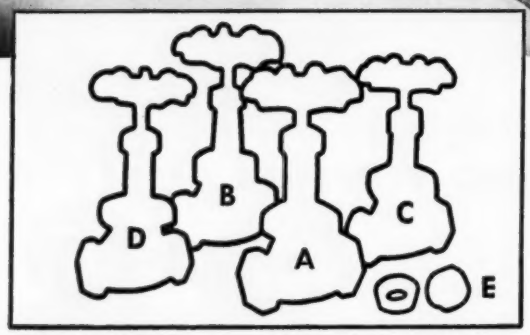
CENTRIFUGAL SPECIALISTS





A — No. 225P.....350 WSP 550F, 1000 WOG
B — No. 260P.....300 WSP 550F, 600 WOG
C — No. 245P.....200 WSP 550F, 400 WOG
D — No. 237P.....150 WSP 500F, 300 WOG
E — "500 Brinell" Stainless Steel Plug Type Seat and Disc

Walworth offers four lines of Bronze Globe Valves with stainless steel, plug-type seats and discs. Advantages of these valves include:

• **Stainless Steel Plug-Type Seats and Discs,** heat-treated to a minimum of 500 Brinell hardness reduces wire-drawing to a minimum. Seats and Discs are machined and fitted simultaneously, assuring perfect mating.

• **Deep Stuffing Boxes with Glands** are fitted with reinforced, molded packing. Valves can be repacked under pressure when fully opened.

For Longer Bronze Valve Life . . .

"500 BRINELL" PLUG-TYPE STAINLESS STEEL SEATS AND DISCS

150 lb. 200 lb. 300 lb. 350 lb.

• **Oversize Stems,** made of high tensile strength silicon-bronze, assure long life.

• **Rugged Body Hexes,** are flat on top; do not interfere with wrench gripping body-to-bonnet union ring connection.

• **Bodies,** made of Composition M bronze (ASTM B61), have ample wall thickness to provide high safety factor.

• **Patented Handwheels** are air-cooled and designed with a "finger-fit grip." Makes turning easy even when wearing greasy gloves.

• **Identification Plates** secured by lock-washer under stem nut, show Figure Number of valves and make re-ordering sure and easy.

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U.S.I. CHEMICAL NEWS

May ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1958

A.I.Ch.E. Marks 50 Years Of Progress This June

The American Institute of Chemical Engineers celebrates its Golden Jubilee this year. During the week of June 22, leaders of the American chemical industries, internationally-known figures in the chemical engineering field, and thousands of other members of the A.I.Ch.E. will gather at Philadelphia to attend technical sessions and the official banquet, and to witness the awarding of special achievement citations.

Since 1908, the American chemical process industries and the A.I.Ch.E. have grown together, helping each other advance into the present "Age of Chemistry." The A.I.Ch.E. has been a guiding force behind this progress. U.S.I. itself, founded in 1906 as a producer of industrial alcohol, could hardly have attained its present size and diversification without its chemical engineers and the organization behind them.

To quote the publisher of the Institute's official organ: "From the impressive plateau of its 50 years of progress, the American Institute of Chemical Engineers can look back with pride on a record of outstanding achievement, and forward with confidence to continued service to mankind."

New Lanolin Derivatives Soluble in Water, Alcohol

Polyoxyethylene derivatives of acetylated lanolin have been developed which are completely soluble in water, alcohol, and many oils and solvents. They yield persistent emollient films and have solubilizing properties desirable in cosmetics, pharmaceuticals, toiletries and aerosol formulations.

The materials are non-greasy, clear liquids designed to give a soft, non-tacky after-feel when incorporated into water and alcohol preparations and emulsions. They are produced in two forms: completely acetylated for applications where a high alcohol content is essential; and partially acetylated for aqueous and weak alcohol preparations. The higher the degree of acetylation the greater the hydrophobic and substantive characteristics of the material.

These new lanolin derivatives are suggested for aerosols, shave lotions and creams, hair tonics, rinses and shampoos, insect repellents and sunscreens, deodorants, anesthetics and antiseptics, among many other drug and cosmetic use possibilities.

Fluorinated Polyethylene Keeps Air and Gases Out, Odors and Flavors In

A recent patent claims that the addition of 0.03-3.5% by weight of fluorine to the surface of polyethylene films and bottles makes them substantially impermeable to atmospheric gases, perfume components, aromatic flavor constituents, and preserving or pressurizing gases. The properties of the polyethylene remain

MORE

SRE and Shippingport Reactor Mark Important "Firsts" in Atomic Power Program

SRE First Reactor to Supply Heat to Conventional Power Plant; Shippingport First Complete Commercial Atomic Power Plant

The Sodium Reactor Experiment in Southern California — first non-military nuclear reactor to feed heat into commercial power generating equipment for conversion to electricity — is a sodium-cooled, graphite-moderated experimental atomic power plant. Built for the Atomic Energy Commission, its purpose is to develop technical data for designing, constructing and operating full scale nuclear plants which will produce power economically.

In this reactor, liquid sodium metal in a closed system is circulated through the core, picking up reaction heat which it transfers to a second, non-radioactive closed sodium system. From this second system the heat is transferred to the power generation equipment of the Southern California Edison Company.

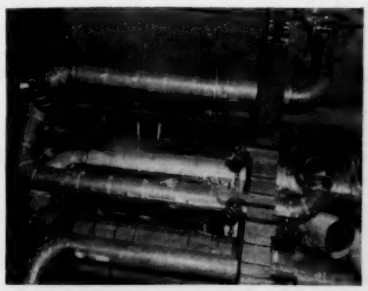
Sodium Coolant Has Advantages

Sodium makes an excellent reactor coolant because of its relatively low neutron-absorbing characteristics, good heat transfer properties, low melting point and high boiling point. High temperatures without high pressure can be produced when sodium is used as coolant.

As part of the experimental program, various fuel elements, components and structural assemblies are being studied in the SRE system. Right now the reactor uses uranium slightly enriched with uranium-235 in the core. Cores containing thorium-uranium alloys are planned for future investigation.

Shippingport Uses Zr, Hf, in Core

The new central-station atomic power plant at Shippingport, Pa. — first in this country to feed electricity into a commercial grid — contains in its core some 14 tons of uranium clad in zirconium metal and zirconium alloy, and control rods made of hafnium and zircaloy.



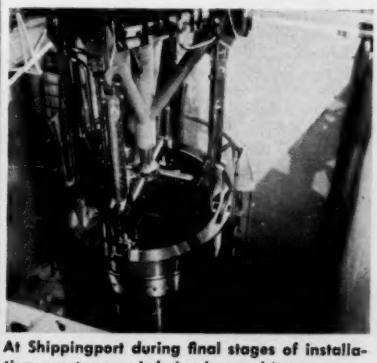
View of sodium-to-sodium heat exchanger which carries heat from SRE core to power generators. (photo courtesy Atomics International)

Zirconium metal has an extremely low nuclear cross-section — allowing free passage of neutrons — and makes an ideal cladding and supporting material for uranium because it offers minimum interference to the fission process, is corrosion and heat resistant, and structurally strong.

In the Shippingport reactor, the core is composed of 32 seed fuel elements containing about 165 pounds of highly enriched uranium clad with zircaloy. These seed elements are surrounded by 113 blanket fuel elements containing 14 tons of natural uranium clad with zirconium alloy.

Hafnium, although found closely associated with zirconium in nature, has the opposite type of cross-section characteristics. It absorbs neutrons readily, and consequently makes excellent control rod material. In the Shippingport reactor core, each of the 32 seed elements has its own two-part control rod. The absorber section is made of hafnium, the follower portion of zirconium alloy.

This pressurized water reactor plant started delivering electricity on December 18, 1957. It uses ordinary water to moderate the nuclear fission process, and the water under pressure is circulated through the reactor core to remove the heat. The hot water is pumped through heat exchangers to produce steam which in turn is used to power the generating turbines. The plant can deliver 60,000 kilowatts into the system of Duquesne Light.



At Shippingport during final stages of installation, reactor core is being lowered into pressure vessel. Zirconium-clad uranium fuel is contained in this core. (photo courtesy Westinghouse)

May ★ **U.S.I. CHEMICAL NEWS** ★ 1958

CONTINUED

Polyethylene

unchanged.

This development should make it possible to package foods, colognes, other toiletries containing perfumes, aromatic solvents, mineral and vegetable oils and aerosol formulations in polyethylene films or flexible containers — without loss of volatile constituents or entry of deteriorating gases.

The fluorination process is claimed to be simple and economical. Film or bottles are washed free of lint, grease, dust and all foreign matter which might cause fluorine to ignite the polyethylene. After this, the film or container is contacted with pure fluorine or a fluorine-inert gas mixture, at room temperature or at up to 50°C. The length of contact varies depending upon the equipment, fluorine concentration, temperature and thickness of film or bottle.

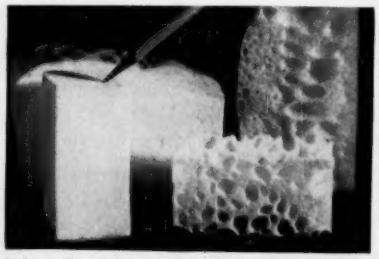
While clarity, flexibility, tensile strength, heat sealability and ultraviolet transmittal are claimed to remain unchanged, permeability of the polyethylene is decreased many fold. In a typical test with a volatile liquid, 5.6% of allyl caproate was lost from an untreated polyethylene bottle in 40 days. Only 0.05% was lost from a bottle which had received a six-hour fluorine treatment. Testing for oxygen transfer, an untreated film transmitted 303 cc per 100 square inches of surface in 24 hours. A treated film transmitted only 46 cc.

Silicone Additives Insure Uniform Cell Structure in Flexible Urethane Foams

Silicones are now being added to flexible polyurethane foams to give smaller, more even cell structure, uniform resilience and flexibility, and better appearance.

One type is a water-dispersible emulsion which can be added directly to the catalyst phase of the foam system. The manufacturer recommends that it be added as the last component when making up this phase, and claims that it will remain uniformly dispersed from several days to two weeks in most catalyst systems. Another type is a fluid added directly to the prepolymer and dispersed by thorough agitation.

Flexible polyurethane foams have evoked wide-spread interest as insulation for both industrial and consumer use, as cushioning, and for a variety of specialty applications. They can be produced from the reaction of polyesters with diisocyanates. An intermediate that can be used to produce the polyesters is U.S.I. ISOSEBACIC® Acid, a mixture of C-10 dibasic acids.



Polyurethane foam containing silicone additive has smaller, more uniform cell structure than other samples containing no silicone.

New Sterilizing Method Employs Ethylene Oxide in Safe Aerosol Formulation

The U. S. Department of Agriculture's Entomology Research Division reports that they have found a way to combine highly volatile ethylene oxide with ordinary aerosol propellants to form a non-flammable sterilizing formulation.

Ethylene oxide is a known germicide, insecticide and sterilant, but its highly flammable nature has been a deterrent to its widespread use for these applications.

The new aerosol is designed for sterilizing sensitive materials which cannot stand treatment by steam, dry heat or liquid chemicals.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Radioactive isotopes and isotope-labeled compounds are described in a new price list now available. Included are C-14 compounds, heavy water, deuterium- and tritium-labeled compounds, N-15 compounds of high isotopic concentration. **No. 1350**

Fatty amines are discussed in new 24-page booklet covering method of manufacture, applications, chemical reactions, vapor pressure, solubility and handling. **No. 1351**

1723 Voluntary national standards approved by the American Standards Association are listed in free 67-page index just published. Standards in fields of chemicals, petroleum, rubber, textiles, are included among others. **No. 1352**

Sodium dispersions which improve chemical reaction efficiencies by providing more active surface area are described in 42-page booklet. Latest production equipment for continuous preparation of dispersions covered. **No. 1353**

Paper-strip electrophoresis analysis of various proteins, hemoglobins, amino acids and many organic and inorganic mixtures is outlined in a new catalog describing equipment for the purpose. **No. 1354**

New organic phosphate insecticide (O,O-diethyl S-p-chlorophenyl-thiomethyl phosphorodithicate) is claimed non-systemic, long-residual, less hazardous than many other organic phosphates. For control of mites and broad range of other insects. **No. 1355**

Plastic pipe for safe transportation of drinking water is discussed in new 12-page folder. Includes types of plastics used, method of joining lengths, suitable applications, standards set by Natl. Sanitation Foundation. **No. 1356**

Chemical analysis of solid surfaces by nuclear methods is described in 33-page U. S. Army report which can now be purchased. Methods used to detect all elements to depth of several microns (sensitivities from 10^{8}-10^{16} gm/cm²). **No. 1357**

Dangerous properties of over 8,500 chemicals, and safe practices in handling, storing and shipping, are outlined in a 1476-page book just put on sale. Toxicity, fire, radiation, air pollution, explosion hazards are covered. **No. 1358**

Tritiated thymidine is now offered in research quantities as a new tool for studies of growth. Material is said to be suitable for investigating cell formation and turnover, genetic patterns, effects of intracellular radiation and growth inhibition in neoplasms. **No. 1359**

PRODUCTS OF U.S.I.

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Sodium, Metallic: cast solid in tank cars, steel drums, pails; bricks in barrels, pails.

Sodium Peroxide, Sodium Sulfite, Sodium Sulfate

Ammonia, Anhydrous: commercial & refrigeration. Tank cars or tank wagons.

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Phosphatic Fertilizer Solution: wet process phosphoric acid.

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Organic Solvents and Intermediates: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, ISOSEBACIC® Acid, Sebacic Acid, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Pelargonic Acid, and 2-Ethyl Heptanoic Acid.

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pantothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K_3), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permadry, Vitamin B_{12} Feed Supplements, Vitamin D_3, Vitamin E Products, Vitamin E and BHT Products.

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- **can handle several materials through one pump and pipeline without contamination**

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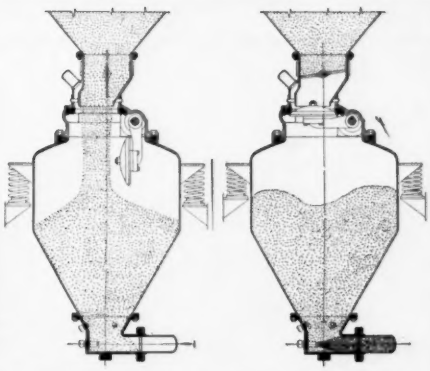
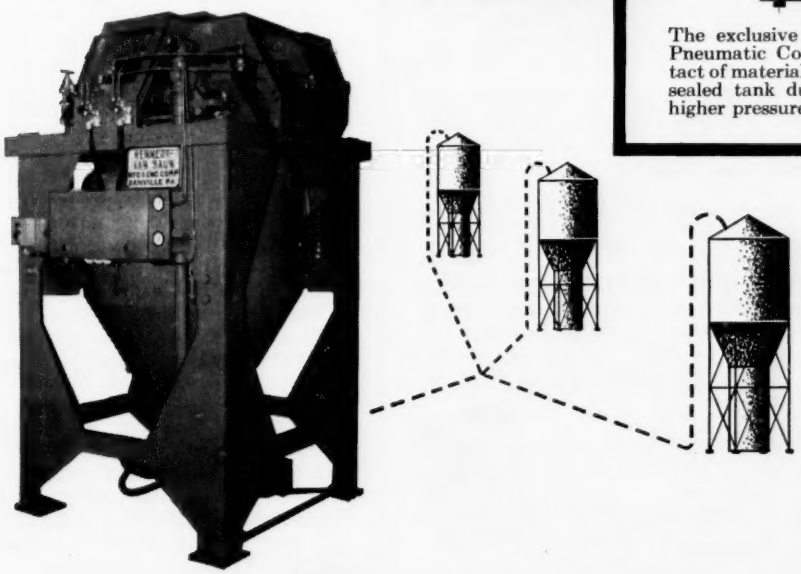


The exclusive batch cycle of the KENNEDY Pneumatic Conveying Pump eliminates contact of material with moving parts. Completely sealed tank during discharge permits use of higher pressures for greatest efficiency.



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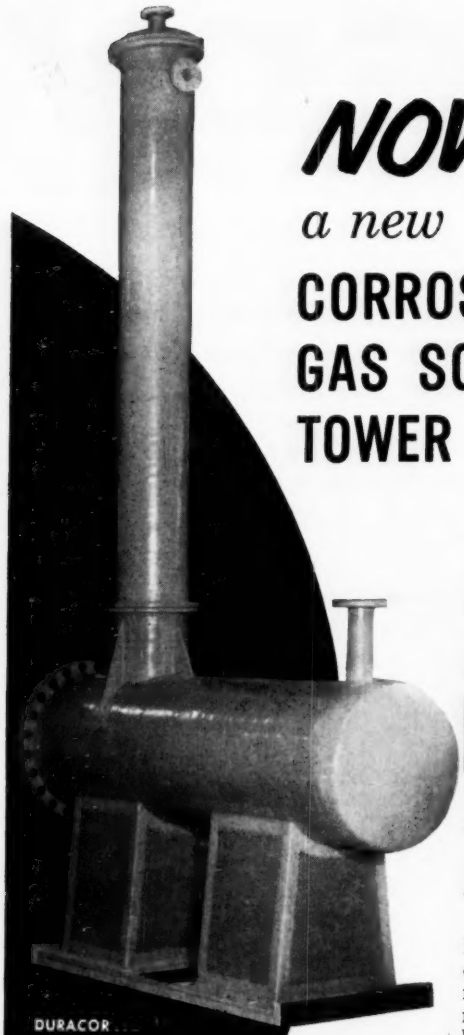

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Tensile Strength:
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Resists many acids, alkalies and solvents.

PROBLEM: A large zirconium producer needed a material to withstand corrosive gases entering scrubbing towers at +300° F.

SOLUTION: Working from customer specifications, Ceilcote engineers designed and built this unit — base, body and tower — *completely from* DURACOR.

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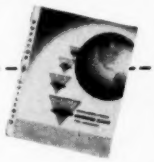

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PEOPLE . . .

NAMES IN

Carl M. Furgason

Carl M. Furgason, who has a background of 15 years experience in the field of process plant design and construction, has joined Russell Engineering Corp., Houston, Tex., as engineer and office manager.

He will spend most of his time in design, estimating and purchasing for the construction of gas and other types of processing plants.

A chemical engineering graduate from the University of Texas, Furgason was an instructor in physical chemistry and physics at the University of Texas and worked as a process engineer with the Tennessee Valley Authority in Florence, Ala. Later he was research project leader at the University on high pressure reinforced plastics.

In 1951 Furgason joined Thermal Products Co., Houston, where he specialized in thermal insulation in refinery and chemical plant operations. His duties included estimating and contracting installations of industrial thermal insulation as well as investigating industrial applications of reinforced plastics.

Edward A. Taylor has been named plant manager of the new West Elizabeth plant of Pennsylvania Industrial Chemical Corp. The plant will turn out hydrocarbon resins and aromatic solvents.

James D. Adams has been named western representative on the technical staff of Rowe

THE NEWS

M. A. GIBBONS

Products, Inc., Niagara Falls, N. Y.

A. C. Hamstead and **H. M. Rife** have been appointed staff associates in Union Carbide Chemicals' development department, at South Charleston, W. Va.

Raymond Wynkoop has joined Sun Oil Co.'s research and development division as assistant director—petrochemicals, in Philadelphia. Recently, he had been assistant to the president of Houdry Process Corp.

Edward Teller, key figure in the development of the hydrogen bomb, has been named director of the Livermore section of the University of California Radiation Laboratory.

J. E. Burrell

J. Earl Burrell has been appointed general manager of operations for Columbia-Southern Chemical Corp., succeeding the late Robert L. Hutchison who served as vice president in charge of operations.

Upon graduation from the University of Michigan in 1941, Burrell joined Columbia-Southern at Barberton, Ohio, as a research and development engineer.

Following various operating and technical assignments at Barberton, he was transferred to the Natrium, W. Va., plant as operations superintendent in 1952. He was appointed assist-

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The Type 9 Seal has and continues to solve innumerable problems where difficult-to-handle liquids and gases are involved . . . at pressures up to 750 psi. It can do the same for you.

Use the Type 9 Seal on all rotating shaft equipment—centrifugal and rotary pumps, mixers, agitators, autoclaves, other equipment.

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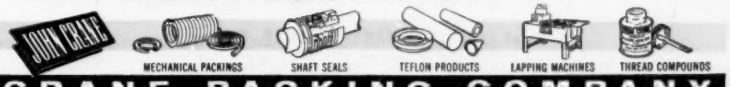
Crane Packing Co., 6451 Oakton St., Morton Grove, Ill., (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*



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Labor savings will pay for these 6 new BATCH-MASTERS® in less than 2 years

Nutley, N. J. — In expanding its production facilities for Gantrisin, one of their sulfa group pharmaceuticals, Hoffmann-LaRoche, Inc., had the option of selecting nine 48″ conventional centrifugals or six 48″ Tolhurst Batch-Master® machines.

After considering that only one man is required to tend each two "Batch-Masters," while four men are needed for every three conventional units, the manufacturer decided on the former machines. The resulting 75% labor savings will offset the total cost of the new machines in approximately 18 months.

The "Batch-Master's" fast bottom discharge and hydraulic unloading make the difference in labor requirements and in batch processing cycle time.

FOR MORE COMPLETE DATA, SEE TOLHURST'S SECTION IN CHEMICAL ENGINEERING CATALOG or write

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American Machine and Metals, Inc.

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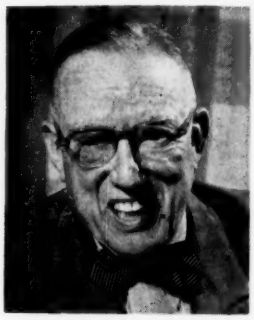
ant to the vice president, operations, with headquarters at the corporation's Pittsburgh, Pa., general office in 1956—a post he has held until his recent appointment.



Paul D. V. Manning

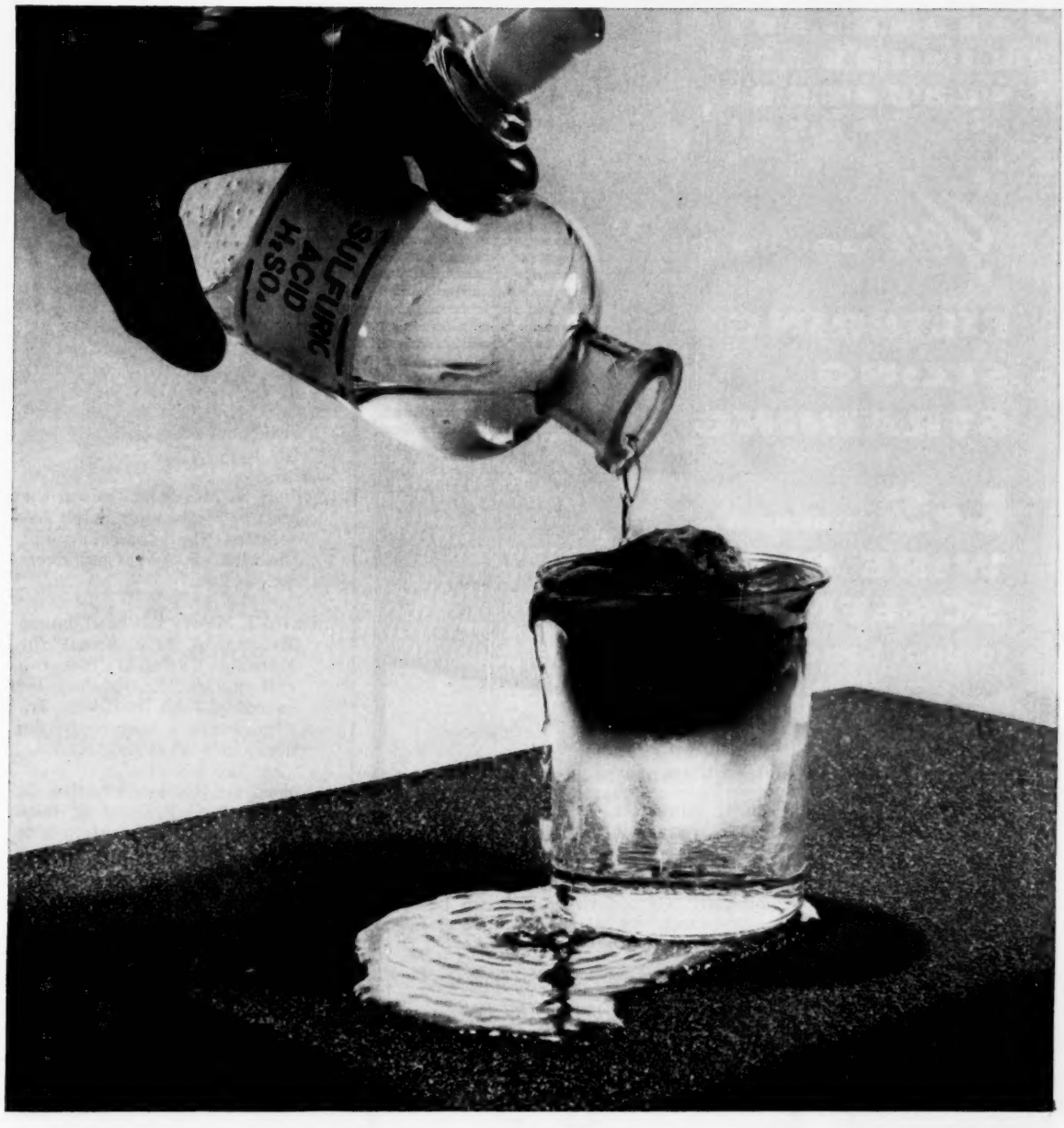
Following his retirement on June 30 from his position as senior technical vice president, International Minerals & Chemical Corp., Paul D. V. Manning will become professor of chemical engineering at the California Institute of Technology.

A specialist in the field of chemical engineering and research administration, Manning's career has included editing, teaching and lecturing in addition to his industrial research positions. He is the holder and co-holder of a number of U. S. and foreign patents.

Before joining IMC in 1941, Manning had been for 14 years Pacific Coast editor in San Francisco of *Chemical and Metallurgical Engineering*. During the same period he was a consulting engineer, vice president and member of the board of directors of Marine Magnesium Chemical Co., vice president of the Western Condensing Co. and director of research for Golden State Co. Ltd.

G. W. Govier, head of the department of chemical engineering, University of Alberta, Edmonton, has been named president of the Professional Engineers Ass'n of Alberta for 1958.

Richard W. Eddy has been promoted to the position of man-



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SINCE 1856

ager, new chemicals division, Union Carbide Chemicals Co. He has been assistant manager of the department since 1955.

J. W. Coonen has been named plant engineer of Goodyear Tire & Rubber's new Videne polyester film facility at Apple Grove, W. Va.

Clarence R. Flynn has been selected to head up the technical department at B. F. Goodrich Chemical's new general chemicals plant in Henry, Ill.

Sidney A. Moses has joined the staff of McCormick Selph Associates. He'll take charge of the high explosives engineering section.

David T. Mowry has been named director of development for Monsanto Chemical's research and engineering division. He succeeds **John J. Healy, Jr.**, who is now a member of the firm's new planning staff.

James C. Rigsby, Charles L. Mullin and **Richard G. Roberds** have been assigned to Olin Mathieson's industrial chemicals division as chemical engineers at the Lake Charles, La., plant.

OBITUARIES

Edward Bartow, professor emeritus of chemistry at the State University of Iowa, died in Iowa City on April 12. Bartow was head of the university's chemistry and chemical engineering departments from 1920 until 1940.

A. Stanley Fromholz, a chemical engineer, died April 12 in Darien, Conn. at the age of 58. Fromholz served as director of the chemical engineering division at American Cyanamid Co.'s Stamford research laboratory. After World War II he became a member of an American team that investigated German scientific development in Germany. In 1954 he became associated with the government's Ordnance Corps.

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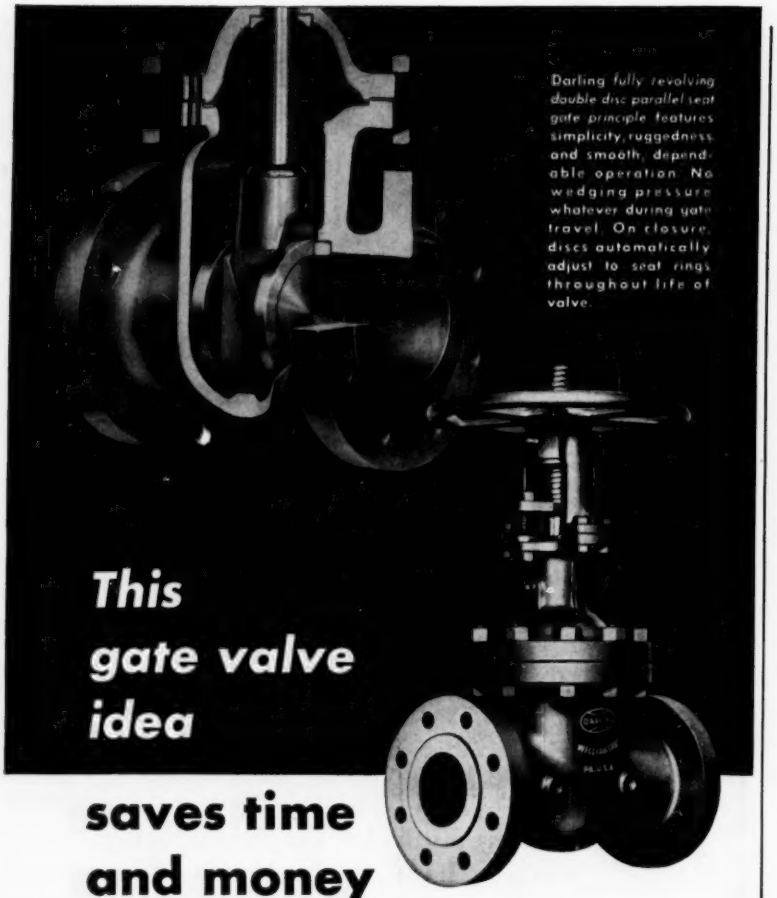
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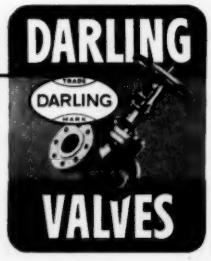

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215 *Norton Co., Electrochem. Div.

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207-8j *U.S.I. Chem.

Furfural.....Quaker Oats Chemical Division has put out a new copy of the complete physical properties of furfural, including the general, fluid and thermodynamic properties. Write for Bul. 203A.
194 *Quaker Oats Co. Chem. Dept.

Insecticide.....Trithion is a non-systematic, long-residual organic phosphate effective on mites and other insects. Brochure indicates which insects compound controls, official tolerances, toxicology.
216A Stauffer Chemical Co.

* From advertisement, this issue

LITERATURE

Insecticide, Phosphate . . . . . (O,O-diethyl S-p-chlorophenyl-thio-methyl phosphorodithicate) is claimed non-systemic, long-residual, less hazardous for the control of mites & broad range of other insects. #1355.
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Isotopes, Radioactive.....& isotope-labeled compounds are described in a new price list now available. Included are C-14 compounds, heavy water, N-15 compounds of high isotopic concentration. #1350.
207-8f *U. S. I. Chem. Co.

Polysulfide Polymers.....Bulletin 2-58 covers results of lab studies including use of aluminum and carbonate fillers, additives for improved glass adhesion based on polysulfide liquid polymers.
217A Thiokol Chemical Corp.

Polyvinyl Chloride.....Roundup of development in PVC are featured in recent issue of American Agile's external house organ. Nine fabrications plus report on cutting and machining of rigid vinyls included.
217B American Agile Corp.

Sodium dispersions.....which improve reaction efficiencies by providing more active surface area are described in 42-page booklet. Latest production equipment for continuous preparation covered. #1353.
207-8i *U. S. I. Chem. Co.

Thiophenols . . . . . Chemistry (sulfur group additions, ring substitution) and end uses (pesticides, pharmaceuticals, dyes, rubber additives, etc.) of thiophenols are contained in 12 p. bulletin.
217C Pitt-Consol Chemical Co.

Thymidine, tritiated . . . . . is now offered in research quantities as a new tool for studies of growth. Material is said to be suitable for investigating call formation & turnover. #1359.
207-8o *U. S. I. Chem.

Zirconium, Hafnium.....16 p. brochure reviews production of zirconium from raw materials; properties of zirconium and hafnium in nuclear reactor applications; mechanical, physical properties of metals.
217D Mallory-Sharon Metals Corp.

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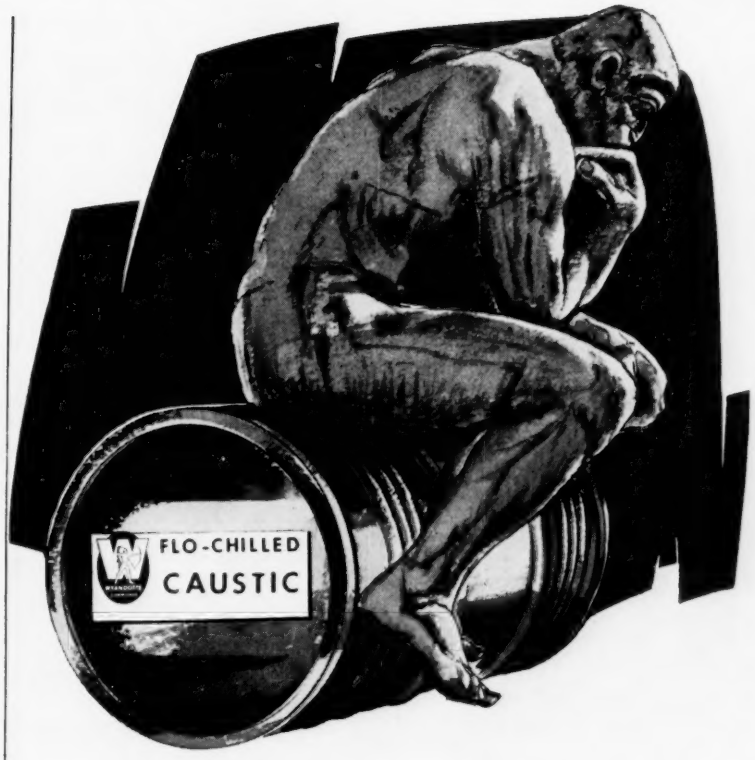

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Construction Materials

Coatings, Bonded.....Bulletin 115, 24 p. manual, details preparation of metal surfaces (steels, chrome, aluminum, magnesium) for proper application of Molykote resin bonded lubricant coatings.
218A Alpha-Molykote Corp.

Coatings, Plastic.....Descriptive 8 p. bulletin shows methods of techniques for producing Reynosol plastic coating. Also shows production views of Ann Arbor, Mich., manufacturing firm.
218B Reynolds Chemical Prod. Co.

Gratings, Steel . . . . . construct stair treads, walkways & floors with steel gratings for safer non-slip footing. For new ideas about grating, space saving platforms & shelving, write for Bulletin 2486.
52 *Blaw-Knox Co.

Insulations . . . . . Foamglas is acid-proof, water-proof & vapor-proof because it is made entirely of glass. Its dimensionally stable, can't burn, unusually strong, & easy & economical to install. Catalog.
140 *Pittsburgh Corning Corp.

Plastics.....Booklet covers matched die molding, vacuum bag molding, contact molding and tube wrapping of Fiberglas reinforced parts. Defines advantages of certain plastics and where they can be used.
218C Atlas Plastics.

Waxes, Floor.....Seven Multi-Clean waxes resist soiling because they are completely free from "tack." Floors cleaned with waxes need cleaning less often; when soiled, dirt's easily removed. Form 1521.
218D Multi-Clean Products.

Electrical & Mechanical

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113 *Falk Corp.

Gaskets.....Bulletin AD-154 describes the complete line of spiral wound gaskets for high temperatures & pressures. Teflon jacketed gaskets for glass pipe flanges provide resilience & deformability.
24-5 *Garlock Packing Co.

Gaskets.....new 24-page booklet for complete coverage on all gaskets & other Metallo products. Designed to meet extreme pressure conditions, wide range of temperatures, & resist corrosion. Catalog CE-2.
192 *Metallo Gasket Co.

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75 *Electric Machinery Mfg. Co.

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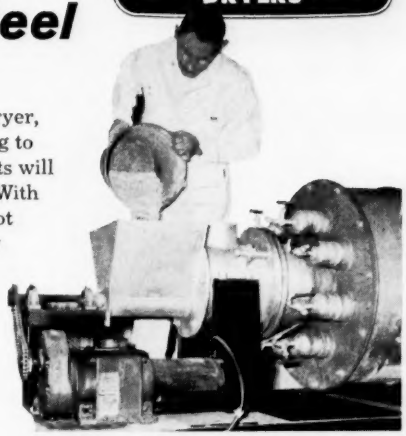

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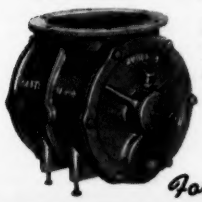

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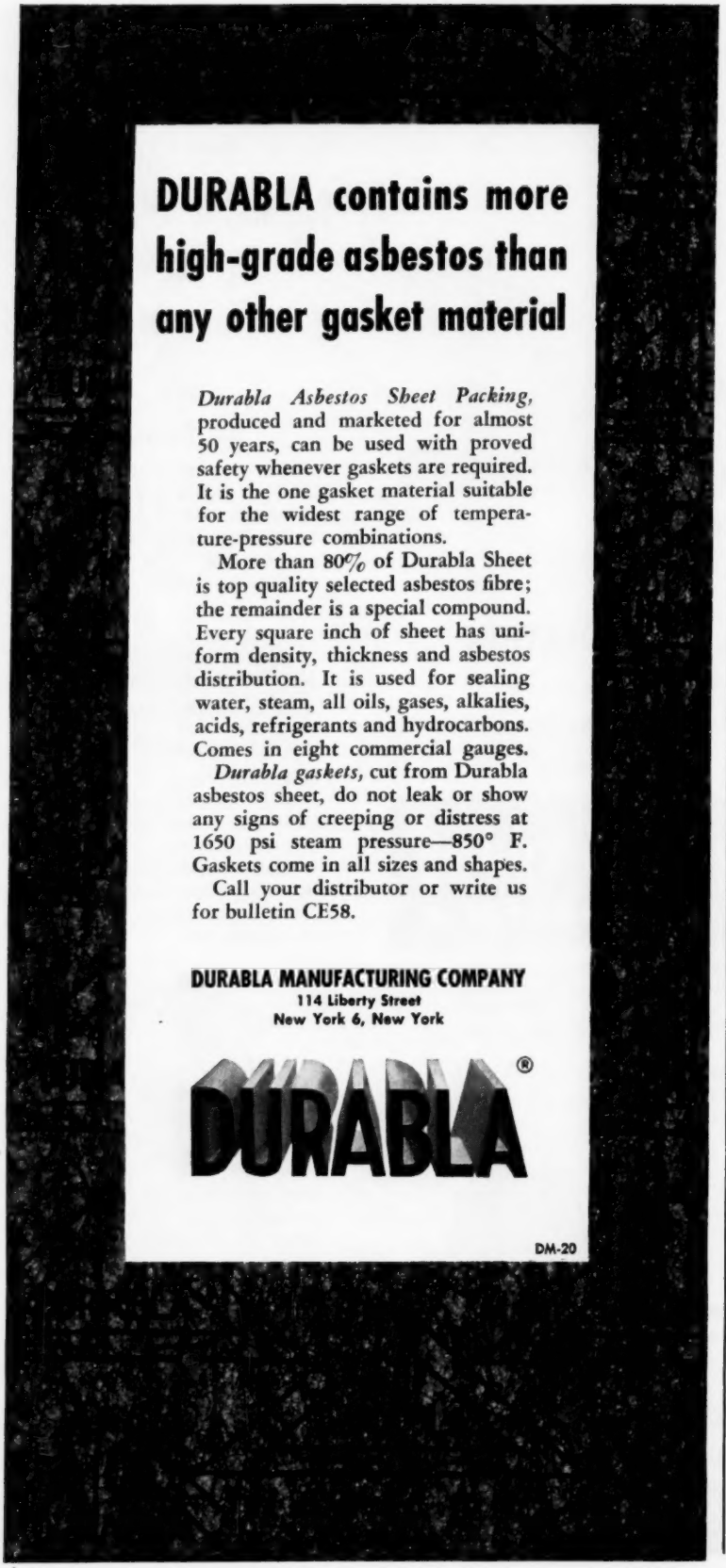
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LITERATURE . . .

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49 *U. S. Electrical Motors, Inc.

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127 Qa-d *Johns-Manville

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185 *Automatic Switch Co.

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117 *Allen-Bradley

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220A Duriron Co.

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220B Texas Instruments Inc.

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220C General Electric Co.

Handling & Packaging

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220D Dave Fischbein Co.

Conveyors.....Brochure consists of field reports submitted by salesmen who have installed Speedways conveyors in 20 different industries with materials handling problems
220E Speedways Conveyors.

* From advertisement, this issue

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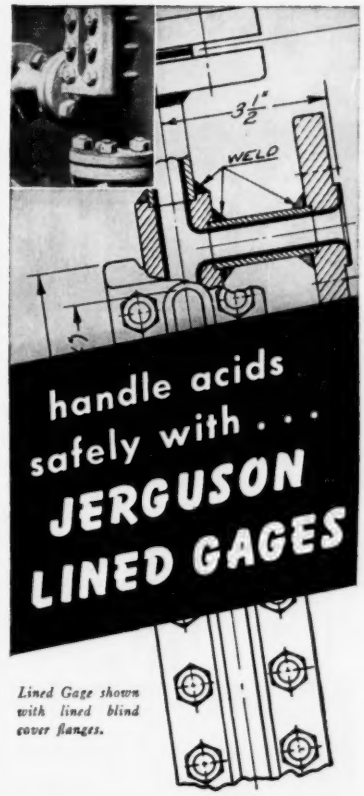

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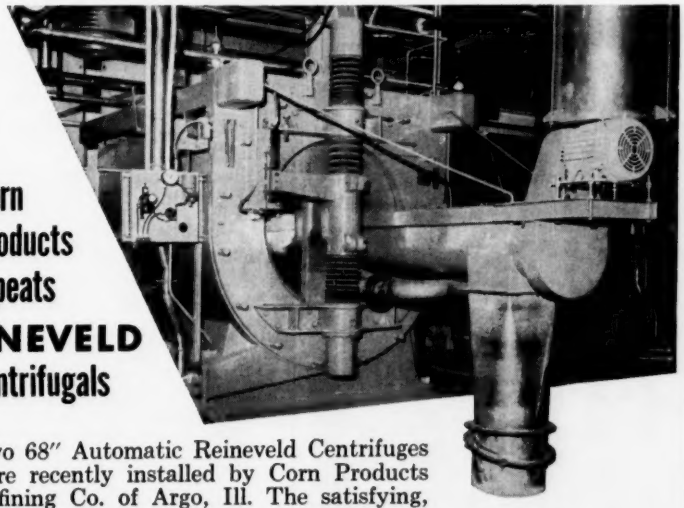

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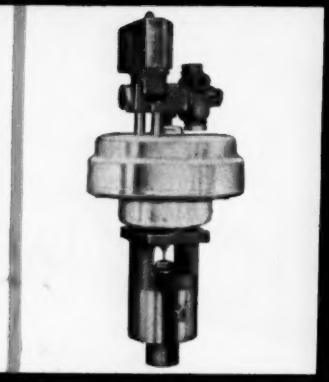

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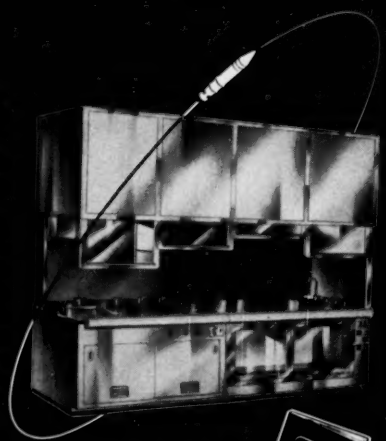

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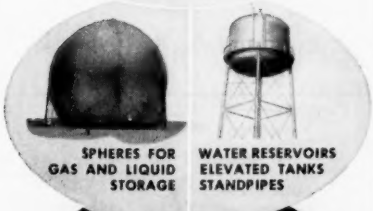

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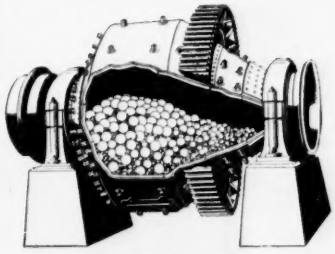

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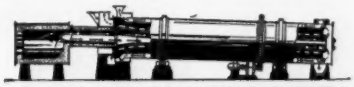

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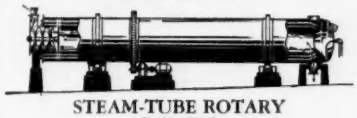

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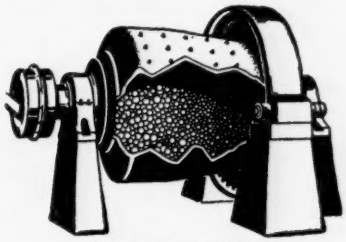

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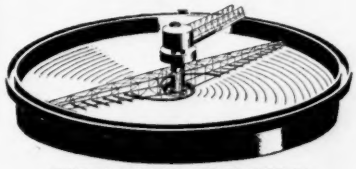

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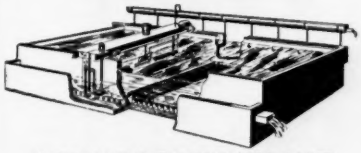

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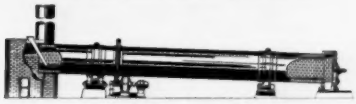

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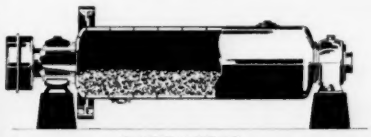

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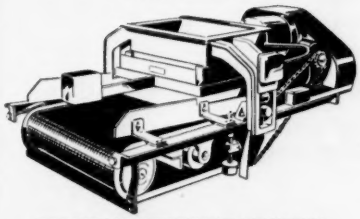

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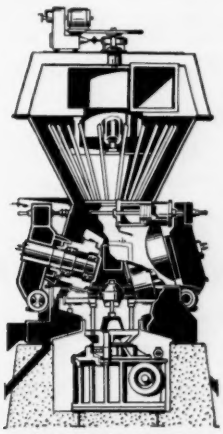

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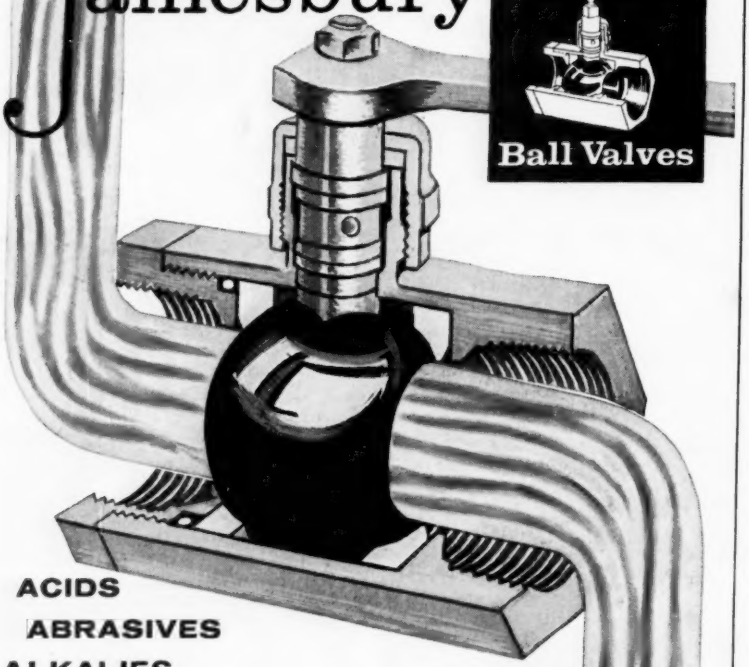

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Cut your flow control costs without sacrificing performance . . .

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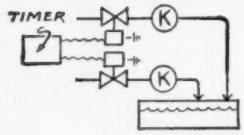
Kates*

*KATES direct-acting flow rate regulators do the job alone. Merely pipe the liquid into and out of the single unit, set the dial, and you get the exact required flow rate even if inlet-to-outlet pressure jumps or drops as much as 125 psi. Use for clear liquids, light slurries, many suspensions.

Standard units are rated from 0.02-0.20 up to 100-550 GPM. Also available with remotely-operated electrical or pneumatic positioners for remote or automatic adjustment. If required, special units can be supplied for unique applications. Kates regulators eliminate hunting, lagging, and wire-drawing, save space, and simplify installation and maintenance.

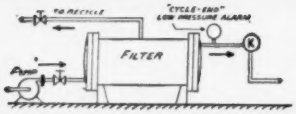
TYPICAL APPLICATIONS

BATCH PROCESS MEASUREMENT



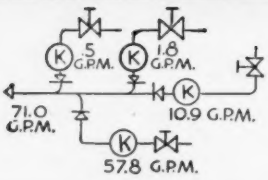
Automatic batch processes are easy when liquid ingredients are fed through Kates regulators and timer-operated solenoid valves. One timer can control all additives since individual flow *rates* can be set at each regulator. And it is easy to change proportions; just change the regulator settings.

PRESSURE FILTRATION CONTROL



As filter cake builds up, a constant valve-jockeying is needed to smooth out flow. A Kates control in the effluent compensates for rising pressure drop, keeps filter at best rating.

PROPORTIONATE BLENDING CONTROL



Where many ingredients go into one blend, and must be in exact proportion, a control *system* for each ingredient would cost plenty. But a Kates control on each feed does the job inexpensively, and each unit can be reset for a blend change.

Write for Technical Bulletins No. 561 and 562 — TODAY

Kates

W. A. KATES COMPANY
Department E
430 Waukegan Rd.
Deerfield, Illinois

LITERATURE . . .
(*Continued from p. 224*)

Transmitter, Pneumatic.....Application of Bailey area meter pneumatic transmitter to flow measurement of water, gasoline, oil, tar, chemicals and distillates is given in Specification P22-4.
228A Bailey Meter Co.

TV Systems, Industrial.....keep an unblinking eye on hazardous atmospheres with closed circuit TV in propane asphalt pilot unit & other style units. Write today for brochure on GPL—the complete line.
L235 *General Precision Lab.

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228B Victaulic Co. of America

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TL221 *Spraying Systems Co.

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228C Swan Engineering Co.

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207-81 *U. S. I. Chem. Co.

Valves.....low cost of valving for difficult processing of corrosive chemicals. Available in a wide range of metal combinations & in several different styles. Request Bulletin 300.
134 *De Zurik Corp.

Valves, Packless.....Development of packless valves for high temperature applications is covered in Bulletin 10-57. Includes several valves designed for control of radioactive material.
228D Hoke.

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216 *Darling Valve & Mfg. Co.

Process Equipment

Agitating & Mixing Equipment..... specify the bulletin that you need from the ad to get the complete story on Nettco engineered agitation. “Process-rated” to your specifications for greater savings.
202 *New England Tank & Tower

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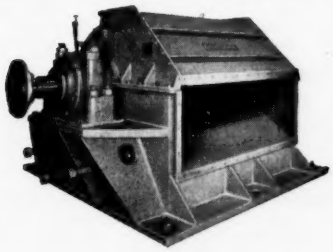
"Since 1885—Gruendler Quality The Best That Money Can Buy"

Unique Heavy Duty Hogs



Knife type hogs for handling big feed and capacities. Rugged duty capable of close adjustment—25 to 800 H.P. for tough materials to be cut, shattered or granulated.

Available with hydraulic or mechanical feeders.

Write Dept. C.E.-558 for illustrated bulletin

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Instead of old-fashioned and obsolete pipe coils up-to-date chemical engineers are now using the modern

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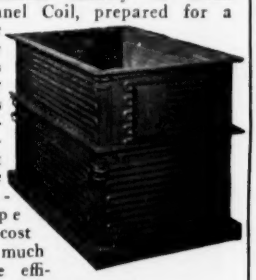
For instance, here we show a tank constructed almost entirely of Dean Thermo-Panel Coil, prepared for a protective coating or lining. It is ideal for many uses in the chemical industry—not possible with old-style pipe coils. The cost is usually much less. More efficient. Better in every way.



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Technical Data Bulletin No. 355 tells all about it. Bulletin 258—Price Data—enables you to do your own estimating. Want 355? 258? Both?

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DEAN PRODUCTS, INC. 612 Franklin Ave
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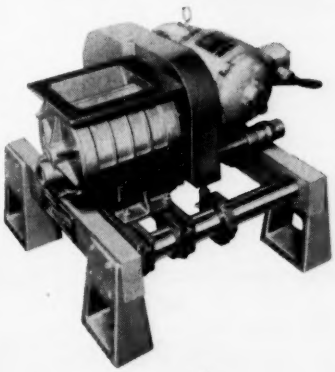
The Superior "FLUIDIZER" Conveying System offers modern, low-cost *handling of most powders, flakes, beads and fine granulars!*

THE SUPERIOR "FLUIDIZER" has outmoded and replaced many standard pneumatic and mechanical conveying devices in chemical plants. It's the industry's most advanced bulk handling system, with many advantages over other systems; high solids-to-air ratio, low power requirements, 50 to 1000 lb. per minute capacities, a complete line of accessories for easy adaptation to automatic operations.

Companies with "FLUIDIZERS" have found them economical to purchase and install. They have found them economical to operate. Many manual jobs and production losses due to manual handling have been eliminated. And, their quality control programs are at new highs.

You, too, may find the Superior "FLUIDIZER" the solution to high production costs. We'll be glad to demonstrate its many profitable advantages.

SUPERIOR IS SELLING ENGINEERING "KNOW-HOW" AND PRODUCTION SKILL



Here is the heart of the industry's finest bulk handling system—the "FLUIDIZER" valve. And here's where Superior's engineering and craftsmanship pays off. The rotor tips, for example, in this star-type rotor are adjustable so that proper clearances can be set for various materials. These clearances must be kept to an absolute minimum, and they may vary only between .001 and .005. This minimum leakage is reflected directly on your horsepower requirements and flow of material. This is only one of the many reasons why so many of the nation's leading chemical manufacturers and processors are handling their materials with a Superior "FLUIDIZER".

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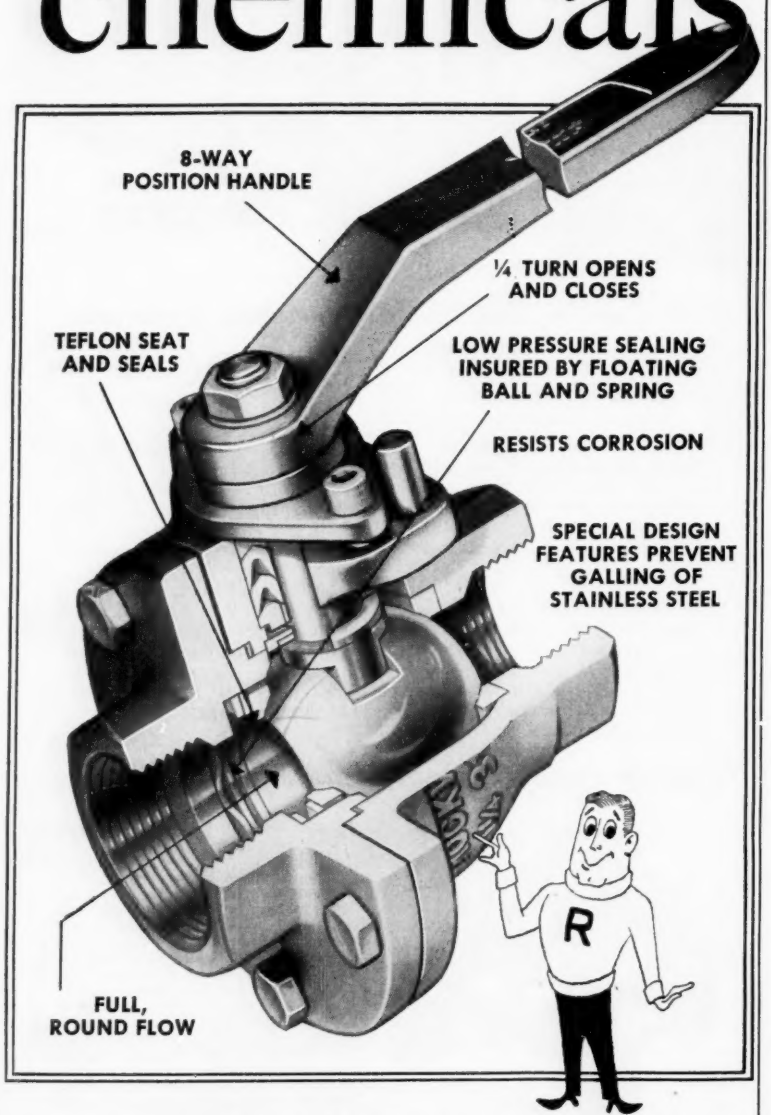
"FLUIDIZER" IS A REGISTERED TRADEMARK OF THE PROCESS MACHINERY DIVISION OF SUPERIOR SEPARATOR COMPANY, HOPKINS, MINNESOTA

Ideal for chemicals



The new Rockwood Ball Valve Type "316" comes with various types of seats, remote air-operation of wanted sizes, ⅜″ through 2″ screwed ends, 3″ — 4″ — 6″ and 8″ flanged ends. 600 W.O.G. — 100°F to 400°F. Tested and listed by Underwriters' Laboratories, Inc. Distributors in all principal industrial areas. Write for full information to —

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BL221 *Heyl & Patterson

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L231 *Sturtevant Mill Co.

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230A Entoleter Div.

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131 *Pangborn Corp.

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R233 *Denver Equipment Co.

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109 *Blaw-Knox Company

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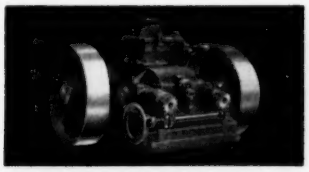
Take Guesswork Out of Lab Crushing & Grinding

Sturtevant Design Provides Easy Access for Cleanouts — Returns Complete Sample

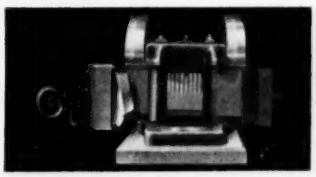
In seconds, because of "Open-Door" accessibility, all Sturtevant crushing or grinding parts are exposed for thorough cleanouts. 100% sample return is easy to secure.

Sturtevant laboratory machines are ruggedly constructed — design, based on production models, gives top lab or pilot performance.

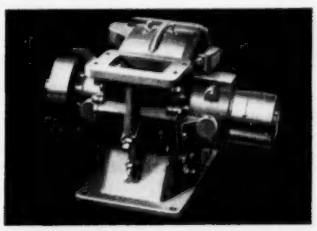
Send for Bulletin No.067, which gives full description of all Sturtevant laboratory machines.



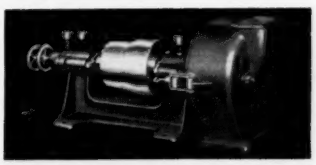
Lab Crushing Rolls: Special lab design. Two models: 8 x 5 in. and 12 x 12 in. rolls. Capacities to 10 tph. Both models adjust down to 20 mesh. Tires of high carbon forgings. Automatic feeder, adjustable controls.



Lab Jaw Crusher: Crushes hardest rocks at ½ to ⅛ in. settings. Roll jaw action — no clogging. Feed opening 2 x 6 in. Capacity to 1900 lbs. per hr. at ½ in. setting. Instant adjustment. Manganese jaws, reversible shield.

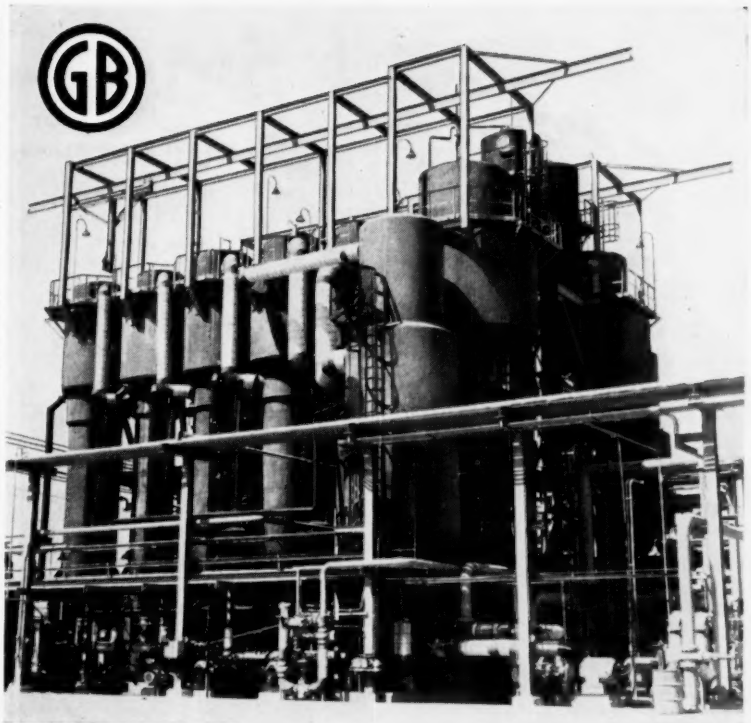


Lab Swing-Sledge Mill: 5 x 6 in. opening takes soft, medium, tough or fibrous feed. Capacity to 1 tph. Fines regulate from 1 in. to 20 mesh. Choice of gratings, hammers (or knives).



Sample Grinder: Disc type grinders for dry, friable soft or medium materials. Three sizes — 6 in., 10 in., and 14 in. take feed as coarse as ¼ in. Produces 100 mesh fines at capacities to 200 lbs. per hr. on largest model. Regulate 10 to 100 mesh. In-operation adjustment.

STURTEVANT
MILL COMPANY
100 Clayton St., Boston 22, Mass.



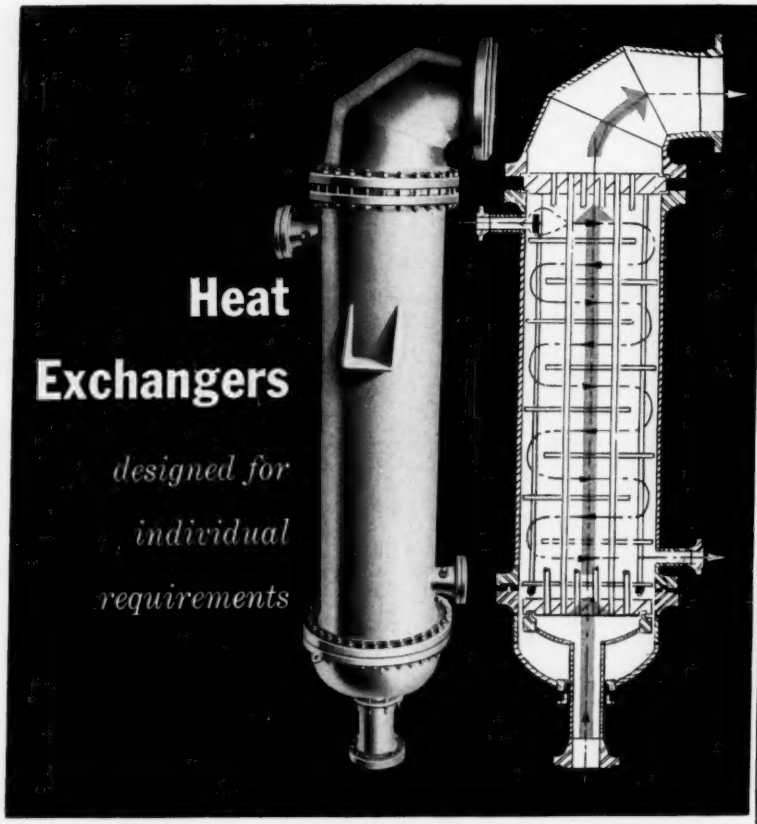
Reynolds Metals Expands with G-B Alumina Liquor Evaporators

Shown here are the original G-B self-supporting, sextuple effect alumina liquor evaporators in use at the Reynolds Metals plant in Corpus Christi, Texas. The fifth and sixth units, offering still greater steam economy with a minimum of fouling will go into use alongside the original units this fall.

This is typical customer-confidence in G-B designed evaporators. From planning board to installation it will pay you to see G-B first!

GOSLIN-BIRMINGHAM
MANUFACTURING CO., INC.
BIRMINGHAM, ALABAMA

FILTERS • EVAPORATORS
PROCESS EQUIPMENT
CONTRACT MANUFACTURING
***including* HEAVY CASTINGS**



Vertical thermosyphon type reboiler.

Forty years experience designing and fabricating equipment to withstand extreme conditions of temperature, pressure and corrosion ... fine facilities ... personal follow-through to meet customers' exact requirements ... all combine to make SWECO *the* dependable source for heat exchangers.

SWECO Heat Exchangers are manufactured from SWECO designs developed to meet the needs of individual clients, or from designs provided by the client. There are several standard types, all of which can be adapted to meet special requirements. Depending on the needs of the installation, they can be fabricated from any of a wide range of materials, including stainless steels, quality carbon steel plate, low alloys, Monel, Inconel, aluminum, copper and brass. Proper allowance for fouling factors assures dependable long-term operation without costly down-time for cleaning and repairs.

As an additional service, SWECO has facilities for rebuilding, replacing and repairing all types of tubular heat exchange equipment. Materials for replacement components held in open stock provide extra-fast service during shut-down periods.

For detailed descriptions and illustrations of SWECO Heat Exchangers, and Pressure Vessels, write for bulletin M-8-32.

SWECO

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Engineers and Constructors ... Manufacturers

LITERATURE . . .

Mill, Impact.....Entoleter centrifugal impact mill uses essentially no cutting and frictional resistance within the machine. Mill pulverizes materials with minimum power requirements.
232A Entoleter Div.

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142 *Simpson Mix-Muller Div.

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141 *Philadelphia Gear Corp.

Mixers, Gearless Pony.....Fast, uniform blending of all ingredients, rugged trouble-free construction, guaranteed product protection, & a model for every need. For full details, write for Bulletin #500.
198 *J. H. Day Co.

Mixer, High-Speed.....Entoleter mixer is centrifugal machine designed to provide thorough mixing and blending in faster time, at reduced cost. Unit is used in continuous mixing; adaptable to batch system.
232B Entoleter Div.

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196 *Hilliard Corporation

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T222 *American Instrument Co.

Process Equipment.....time tested mills, rotary dryers, filters, feeders, rotary coolers & air classifying systems described in our general Catalog 100-A-11 which details complete line.
R223 *Hardinge Co.

Processing Equipment.....1958 full line catalog describes equipment used in such fields as petroleum refining, petrochemicals, chemical processing. Covers items like strainers, spacer rings.
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94a-c *Sprout-Waldron

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115 *Mikro-D Pulverising Mach.

Reactor, Dispersion.....Dispersion reactor for lab work operates at 22,000 rpm. It was designed to produce sodium dispersions, start sluggish reactions, fluidize natural products.
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why take chances?

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TAYLOR COMPARATORS

for FAST, ACCURATE

pH, CHLORINE, PHOSPHATE

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to insure precise control

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Taylor Comparators are durable, lightweight, portable. Many serve for several determinations with only a change of color standard slides.

COLOR STANDARDS GUARANTEED

Be sure to use only Taylor reagents and accessories with Taylor Comparators to assure accurate results. All Taylor liquid color standards carry an unlimited guarantee against fading.

SEE YOUR DEALER for Taylor sets or immediate replacement of supplies. Write direct for FREE HANDBOOK "Modern pH and Chlorine Control". Gives theory and application of pH control. Illustrates and describes complete Taylor line.

W. A. TAYLOR AND CO.
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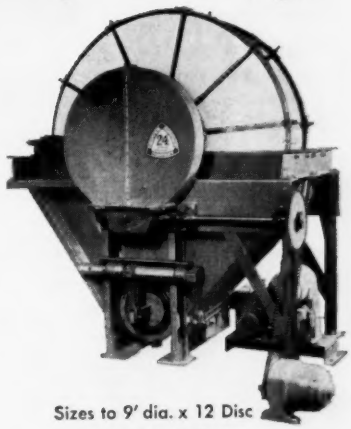
DENVER

AGITATOR-TYPE

DISC FILTERS

Exclusive diaphragm-activated agitating mechanism supplies proper pulp agitation. *No packing glands, no submerged bearings,* no possible contamination from grease or dilution from sealing water. Gives higher filter capacity, lower moisture content and more uniform, dryer filter cake—plus trouble-free, dependable operation.

DENVER Disc Filters without agitator mechanism, DENVER Packaged Filter Units and complete dewatering equipment also available. Laboratory Filtering Test Service at no charge.



Sizes to 9′ dia. x 12 Disc

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DENVER Equipment for the Chemical Process Industries

DENVER Adjustable Stroke Diaphragm Pumps
1″ to 10″ Simplex and Duplex, Capacity to 1000 g.p.m.

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DENVER Drum Filters
Sizes to 6′ dia. x 8′ long.
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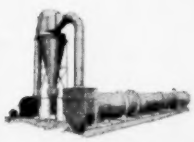

DENVER Dryers
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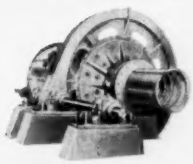

DENVER Steel Head Mills
Sizes to 10′ dia. x 20′ long
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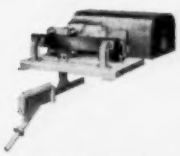

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Specialists in Flotation Engineering

DECO ENGINEERS — DENVER 24 HOUR SERVICE COMPANY

DENVER EQUIPMENT COMPANY

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STANDARD NEMA FRAME MOTOR COUPLED TO THE GEAR UNIT
"International" TYPE LWR
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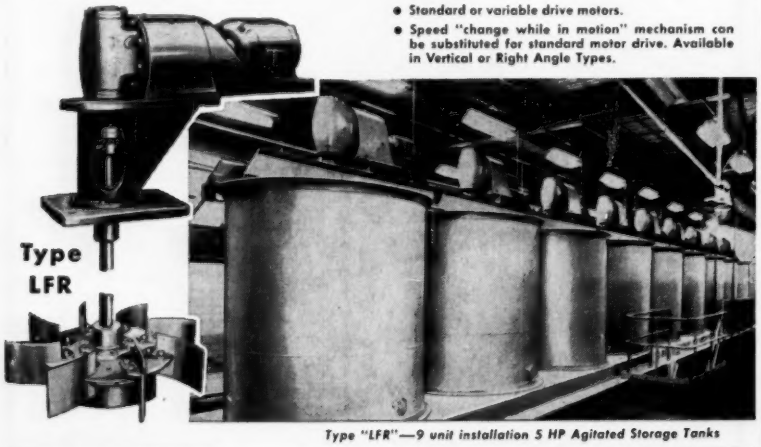

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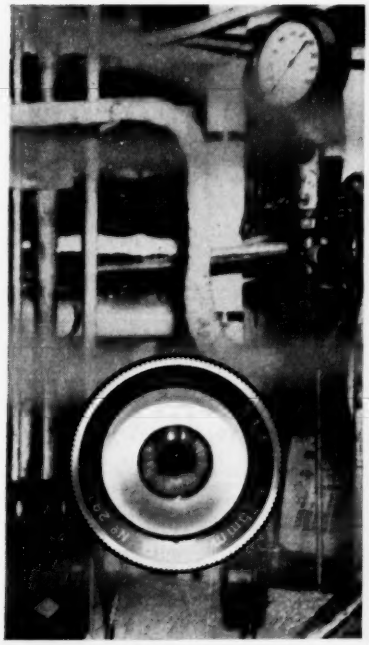

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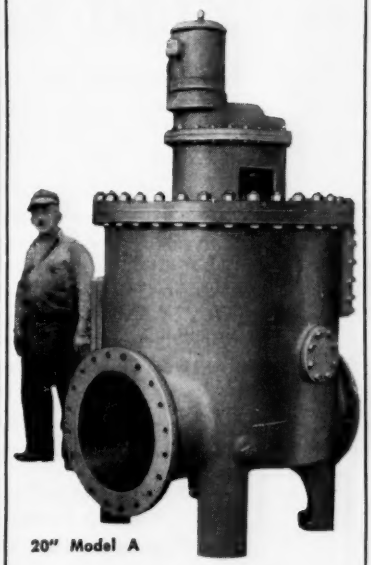

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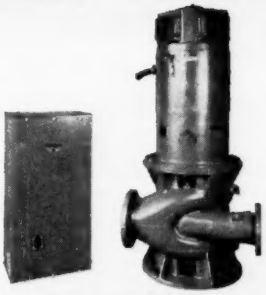

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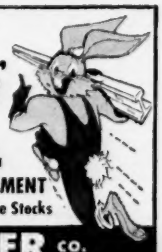

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Devine & Stokes Impreg. Units 30″ & 36″ dia.
Devine 1000 gal. closed jack. Steel Kettle.
1—250 gal. Lead Lined Kettle.
50—Stainless, Alum. Copper, Glass & Lead Lined Kettles & Tanks. Also new Stainless.

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4—Mikro Pulverizers #4, #2SI & 2TH & Bantam.
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Sturtevant #0.18″ Hinged Hammer Mill
Jeffrey 18″ x 18″ Single Roll Crusher.
Day Hercules Snike Crusher 1½ H.P. motor.
Hammer Mills Pulverizers 3 to 50 H.P.
Bauer 24″ Hammer Mill.
1—Schultz O'Neil 20″ Pulverizers, Also #1.
Williams Hammer Mills 7½ to 50 H.P.
1—Robinson 19″ & 22″ Attrition Mill.
1—Lehman 4 Roll W. C. 12 x 36″ Steel Mill.
3—Steel 3 Roll Mills 9″x32″, 12″x30″ & 16″x40″.
Ball & Jewell Rotary Cutters Midget, Lab. & Up.
U. S. 1½ H.P. Colloid Mill.
Eppenbach QV81 Stainless Colloid Mill 5 H.P.

MIXERS & SCREENS
Day Imperial 75 & 150 gal. Jack. Mixers.
Baker Perkins double arm 50 & 100 gals.
2—Read 50 & 100 gal. double arm mixers.
Lancaster 6′ dia. vert. Mixer 25 H.P.
Kent 3 H.P. Continuous Dry Mixer.
3—Day 8, 15 & 40 gal. Pony Mixers.
Read 40 and 80 qt. vertical Mixers.
6—Lead—Paste Mixers 50 to 150 gals.
Robinson 20″ x 48″ Giro Sifter 3 opening.
Blystone 3000# horiz. spiral mixer.
Day Jumbo 700 gal. horiz. Mixer.
10—Dry Spiral Mixers 50 to 3000#.
12—Portable Elec. Agitators ¼ to 5 H.P.

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Colton 5½ T & 4T single Punch preform machine.
Stokes RB2 Rotary Tablet Machine.
Stokes & Colton ½″, ¾″, & 1″ single punch.
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1—J. H. Day stainless steel jacketed Mixer, 1000 gallon, complete
2—Stainless Steel 5000 gallon storage tanks.
3—Pfaudler Glass-lined 100 gallon Type VR Vacuum Receivers

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1—Fletcher stainless steel 48" suspended type Centrifuge, with perforate basket, complete with motor and plow
1—Tolhurst Stainless Steel 32" Suspended Type Centrifuge, with perforate basket, complete with motor and plow
1—AT&M 42" Suspended Type Centrifuge, complete with type 347 stainless steel Perforate basket, plow and curb, with 40/20 HP motor
1—Tolhurst 32" Suspended Type Centrifuge with Imperforate Basket

DRYERS:

4—Link Belt Steel Roto Louvre Dryers, Models 207-10, 310-16, 310-20, 604-20
1—Stokes Stainless Steel Rotary Vacuum Dryer, 3' x 15'
1—Traylor Rotary Dryer, 4' x 40'
1—Buflovak Double Drum Dryer, 42" x 120"
1—Stokes Model 59 DS, Steel Rotary Vacuum Dryer, 5' x 30'
2—Louisville Rotary Steam Tube Dryers, 6' x 50', complete
1—Bartlett & Snow Rotary Dryer 4'6" x 36'6"
6—Stokes Vacuum Shelf Dryers, 2, 4, 6 and 18 shelves
1—Stokes Double Drum Dryer, 5' x 12'
1—Louisville Rotary Steam Tube Dryer, 8' x 45'

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1—Oliver Horizontal Filter, 6'6"
1—Niagara Stainless Steel Filter, Model 510-28
1—Feinc Stainless Steel Rotary String Filter, 3' x 3'
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1—Sweetland #3 Stainless Steel Filter, 70 sq. ft. filtering area
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10—Sweetland #12 Filters with 72 stainless steel leaves

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5—Pfaudler Series R Jacketed Kettles, 1000 gallons
20—Pfaudler 1000 gallon Vacuum Receivers
1—Glascote Glass-lined Jacketed Kettle, 500 gal.
1—Stokes Stainless Steel 500 gal. jacketed Vacuum Kettle
1—Downington Iron Works Steel Pressure Tank, 5000 gal. 200 PSI
1—Nickel 1000 gallon jacketed Kettle
1—Lee Jacketed Stainless Steel Kettle, 125 gallons

THE GELB GIRL—MAY 1958

MIXERS:

2—Robinson Stainless Steel Horizontal Ribbon Blenders, 150 cu. ft. each
1—Entoleter Stainless Steel Continuous Mixer, Type PF
1—Abbe Lennart Jacketed Mixer, 125 gallons
1—Baker Perkins Stainless Steel Double Arm Jacketed Mixer, with compression cover, 2¼ gallons
1—Baker Perkins Stainless Steel Double Arm Jacketed Sigma Blade Mixer, 9 gals.
1—Patterson Steel Jacketed Double Arm Vacuum Mixer, 100 gallons
1—Leader Stainless Steel Jacketed Horizontal Ribbon Blender, 40 cu. ft.
1—Patterson Monel Conical Blender, 4.7 cu. ft.
2—Baker Perkins Double Arm Sigma Blade Jacketed Mixers, 100 gallons
1—Gedge Gray Stainless Steel Ribbon Blender, 65 cu. ft.
1—Banbury Midget Pilot Plant Mixer
3—Robinson Type 316 Stainless Steel Sigma Type Jacketed Heavy Duty Mixers, 400 gallon capacity, 60 HP
1—Process Engineers Stainless Steel Jacketed Ribbon Blender, 30 cu. ft.

MISCELLANEOUS:

2—Williams Hammer Mills Type 316 Stainless Steel Model AK
1—6" x 12" 3 roll Laboratory Calender
4—Type 317 Stainless Steel Heat Exchangers, 892 sq. ft. each., 200 PSI
6—Karbate 60 sq. ft. Heat Exchangers
1—Combustion Engineers Water Tube Package Boilers, 200 HP., 275 pressure
30—Struthers Wells Stainless Steel Heat Exchangers, 650 sq. ft. each

1—Bird 18" x 28" stainless steel solid bowl continuous Centrifuge
1—Baker Perkins Type 316 stainless steel Ter-Meer Centrifuge, Model HS-24"
2—Vertical aluminum storage tanks, 12,000 and 18,000 gal.
1—Buflovak 6" x 8" vacuum double drum dryer.

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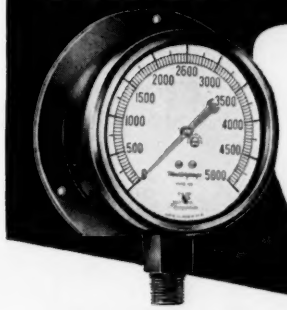

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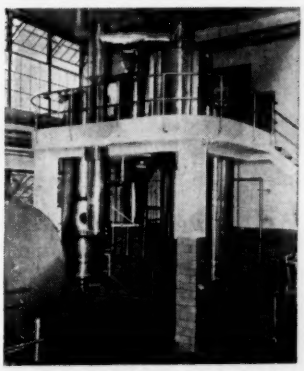

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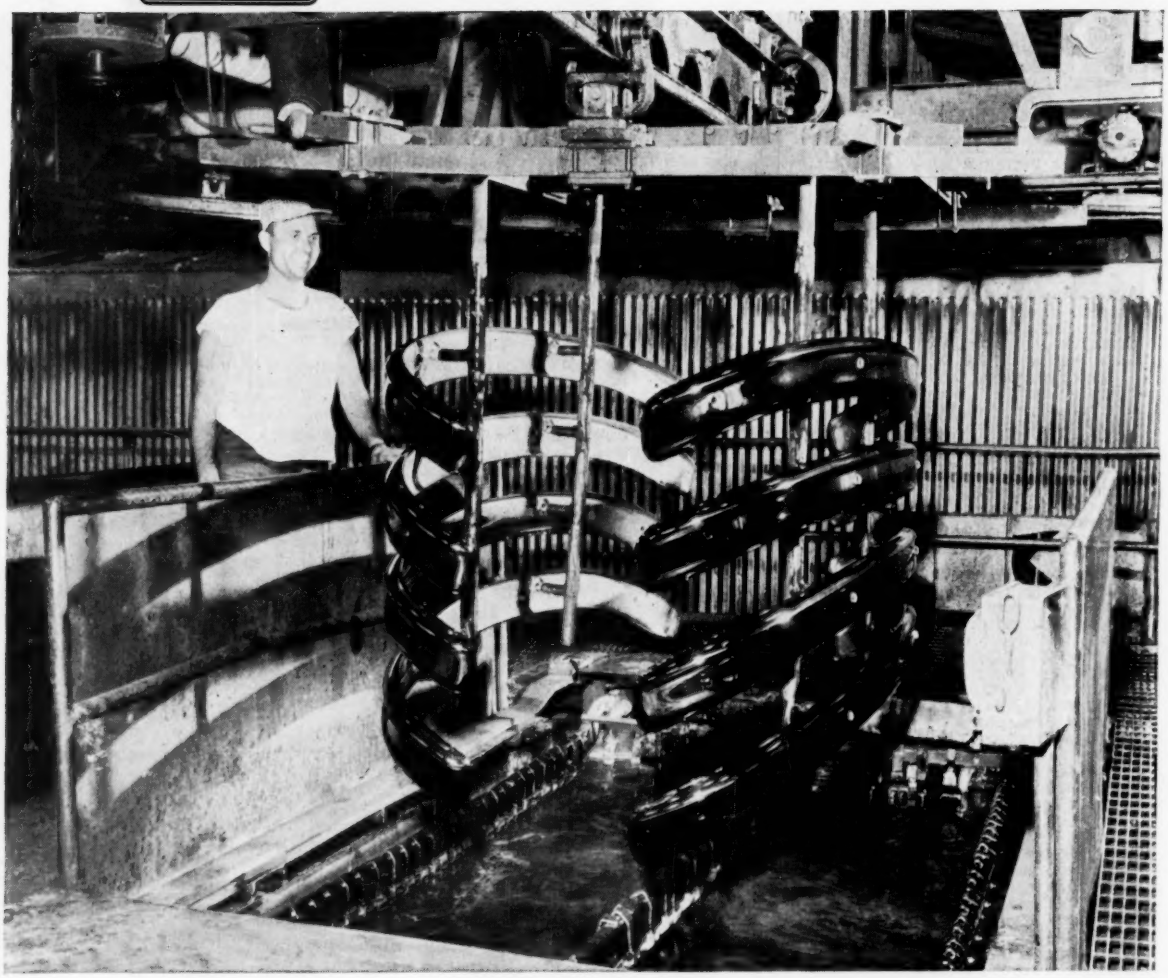

Shiny faces for a bumper crop

B. F. Goodrich product improvements brought extra savings

Problem: Those curved pieces of steel will soon be gleaming bumpers on new automobiles. They're about to be dunked into a plating solution that gives them their shiny chrome finish. But the acid used is so corrosive it would eat holes through metal tank walls.

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What was done: A satisfactory tank seemed impossible until B.F.Goodrich developed Koroseal flexible material that can stand practically all acids. Six tanks were lined with B.F.Goodrich Koroseal.

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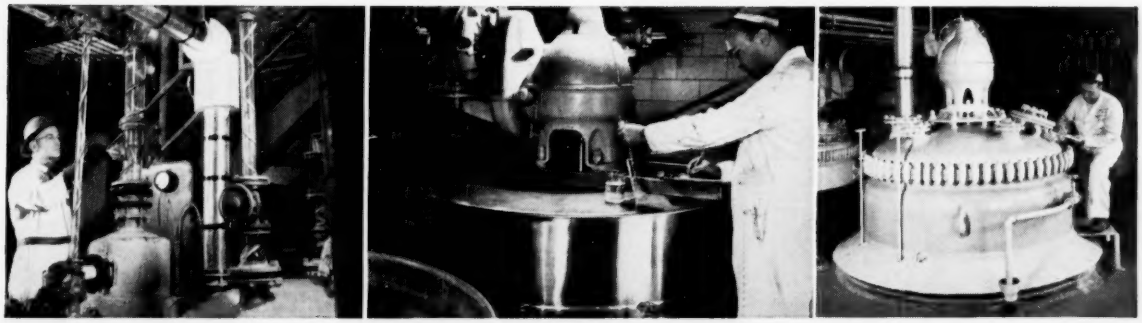

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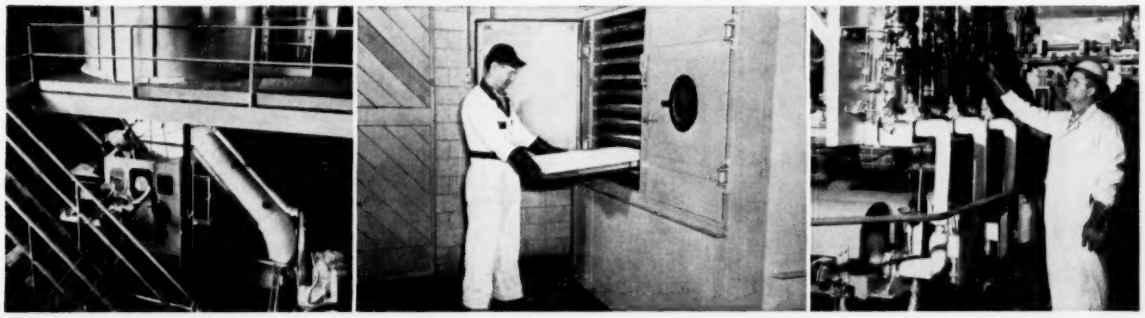

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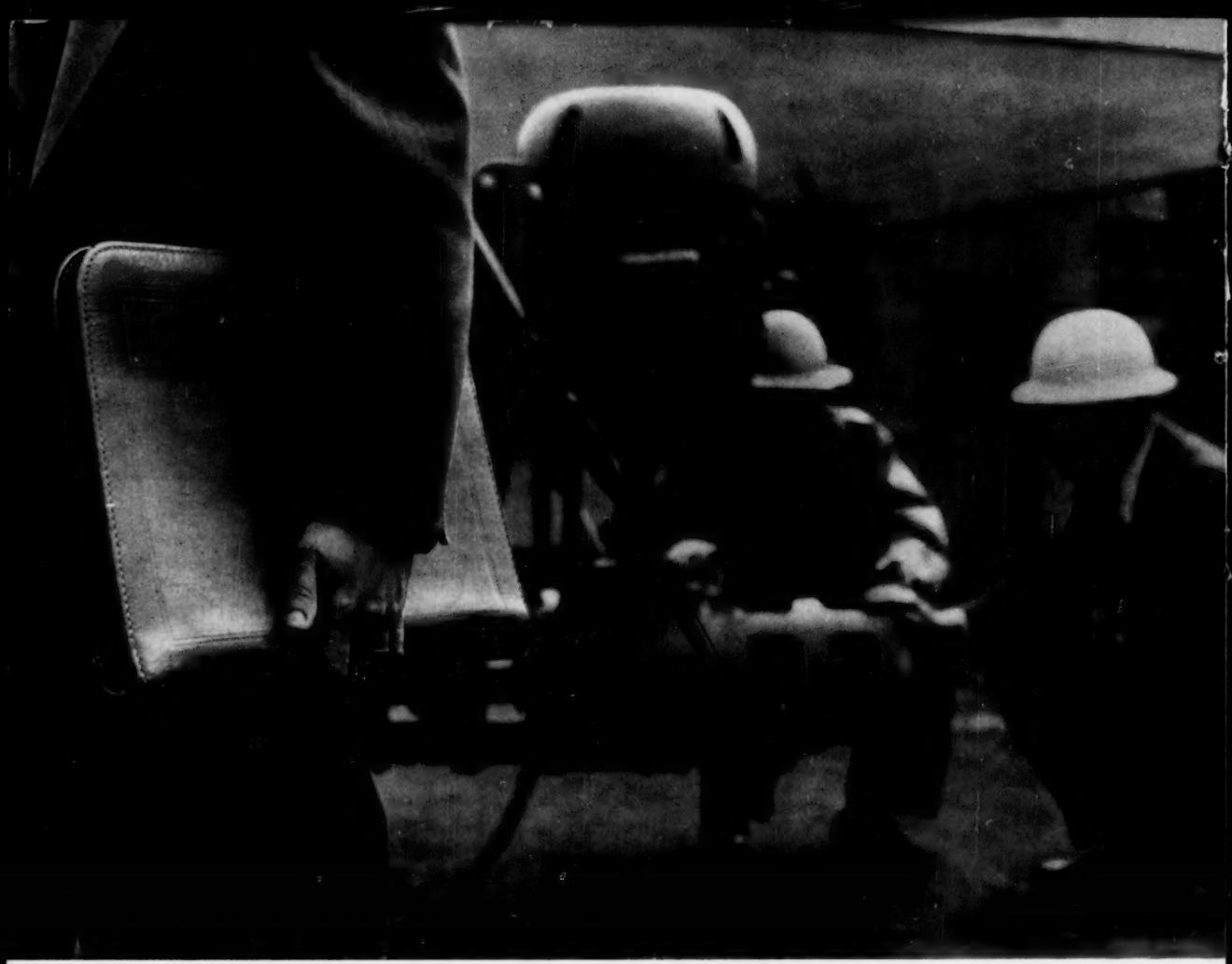

Cost-cutting approach saves $6,000 on fluid mixing

An idea from your LIGHTNIN *Mixer representative's briefcase*

Here's a fluid mixing idea that has already saved a company $6000 on equipment, and is saving many more dollars on operating expense.

In this plant, heavy clay-and-water slurry is mixed in tall tanks. But this operation posed a big maintenance problem, because the long vertical mixer shaft in each tank had to be steadied by a bearing in the tank's bottom. Gritty clay kept getting into this bearing and grinding it to pieces in a few weeks.

Then production had to stop while maintenance men hoisted out the heavy shaft and installed a new bearing. The bearings didn't cost much, but the tab for replacing them was ruinous.

Finally a LIGHTNIN Mixer representative explained how this company could easily mix uniform clay suspensions in its tall tanks—with a *side entering* LIGHTNIN Mixer like the one you see here.

Now there's no maintenance headache, because no steady bearing is needed; so production keeps moving without costly stoppages.

Also, it costs *$6000 less* to install one of these LIGHTNINs than it would cost to replace the older mixers, mainly because no elaborate bracing is required on top of the tank. And this company reports its clay suspensions are much more uniform than before.

What this man can do for you

This is just a sample of the cost-cutting approach to mixing that you get from your LIGHTNIN representative.

He can bring you long-term savings on fluid mixing better than anyone else—because that's his job, and he's an expert at it.

He can help you avoid engineering headaches, too, because his recommendations are based on unique MIXCO pilot-run data guaranteed accurate.

Take advantage of his unmatched experience by calling on him for prompt help on any fluid mixing operation. You'll find his name in Chemical Engineering Catalog. Or write us direct.

Lightnin® Mixers

MIXCO fluid mixing specialists

MIXING EQUIPMENT CO., Inc., 128-e Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Avenue, Toronto 10, Ont.